# ENGINEERING INTERPRETATION OF AGRICULTURE SOIL MAPS AND CORRELATION WITH AIRPHOTO PATTERNS

JUNE, 1956

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by

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Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

ENGINEERING INTERPRETATION OF AGRICULTURAL SOIL

MAPS AND CORRELATION WITH AIRPHOTO PATTERNS

TO: K. B. Woods, Director — June 11, 1956

FROM: Harold L. Michael, Assistant Director — File: 6-6-28
C-36-51I

Attached is a report entitled "Engineering Interpretation of Agricultural Soil Maps and Correlation With Airphoto Patterns" by Mr. D. D. McGregor. This report was prepared under the general supervision of Profs. R. D. Miles and R. E. Frost and was also used by Mr. McGregor as a thesis in partial fulfillment for the Degree of Master of Science in Civil Engineering.

This report contains an engineering soils map of Newton County and sets forth the procedure for the preparation of such maps and existing agricultural maps in a study of Airphoto patterns. The use of these procedures should materially increase the output of soils maps for other Indiana counties.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Assistant Director
Joint Highway Research Project

HLM:ad

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# ENGINEERING INTERPRETATION OF AGRICULTURAL SOIL MAPS AND CORRELATION WITH AIRPHOTO PATTERNS

by

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Joint Highway Research Project

File 6-6-28
C-36-51I

Purdue University
Lafayette, Indiana

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# ABSTRACT

This study was initiated in an effort to determine if agricultural soils data correlated with airphotos would provide a faster and more economical means of completing the Engineering Soils Mapping Program in Indiana.

Newton County was chosen as the area for this study for two reasons; first, a wide variation in soil types occur there, and second, the Agricultural Soil Survey of Newton County is one of the more recent and up-to-date surveys.

The procedures set forth in this study combine a survey of the geologic and physiographic literature and an engineering evaluation of the Agricultural Soil Survey with a study of the airphoto patterns. The resulting engineering soils map has proved sufficiently accurate for its intended purposes and very economical in both time and effort.

In addition to the engineering soils map, typical profiles of agricultural soil series were prepared. These profiles illustrate the engineering characteristics of the soil series found in Newton County and not considered in other publications.

# INTRODUCTION

The purpose of this study is to prepare an engineering soils report utilizing the Agricultural Soil Survey of Newton County as a primary source of data and supplementing it by airphoto interpretation and ground investigation. It is an attempt to facilitate the production of engineering soils maps of Indiana through methods offering economy of time and effort, yet maintaining standards of accurracy in line with the intended uses of these maps.

Newton County was chosen for this study because of the wide variations in soils and because the Agricultural Soil Survey of the county was both recent and accurate.

For a number of years, a considerable number of engineers have known that agricultural soil surveys contained a great amount of information useful in engineering soil surveys. However, in Indiana, no effort has been made to utilize this information as a primary source of data in preparing engineering soil maps of the state. In 1943, the Joint Highway Research Project published Bulletin 87, "The Formation, Distribution, and Engineering Characteristics of Soils," by D.J. Belcher, L.E. Gregg, and K.B. Woods. This publication gave, among other things, the engineering characteristics and typical profiles for most of the agricultural soil series mapped in Indiana at that time. This publication has proved to be of great benefit, particularly to engineers in Indiana.

Since Bulletin 87 was published, a number of new soil

series have been named and mapped. Some of these soils occur in Newton County. The soil profiles illustrated in Appendix A to this study have been prepared on the same basis as those in Bulletin 87, and may be used for the same purposes.

This study has been accomplished utilizing airphoto interpretation and a limited amount of ground investigation to supplement the agricultural soils data available. No attempt is made in this study to reiterate the principles of airphoto interpretation and its applications since a large number of publications have dealt with this subject in detail. Standard methods of field sampling and laboratory testing were utilized in every instance and no explanation of these is warranted.

# CHAPTER I

## PEDOLOGY

To the engineer unfamiliar with the basic principles of pedology and the pedological system of soil classification, Agricultural Soil Surveys are virtually useless for an engineering evaluation of soils. However, when the engineer understands the formation of soil from the pedologists' standpoint, and becomes familiar with the basic terminology used, it becomes apparent that valuable information of engineering significance can be found in these reports.

The terminology of the engineer and the pedologist differ. For instance, soil, to the engineer, represents all unconsolidated material overlying bedrock. The pedologist, however, considers soil to be only that material which has been weathered to the extent that it can support plant life.

Pedology is the science of soil formation. It deals with the factors which influence the formation of soils. These factors are climate, vegetation, topography, parent material, and time. Each has a definite influence on the soil profile.

The soil profile is the result of all the factors which affect soil formation. Pedologists separate the profile into a number of layers, called horizons, and each has its own characteristics and peculiarities. Figure 1 presents a standardized version of the soil profile which is in agreement with most authorities in the field.

# THE SOIL PROFILE

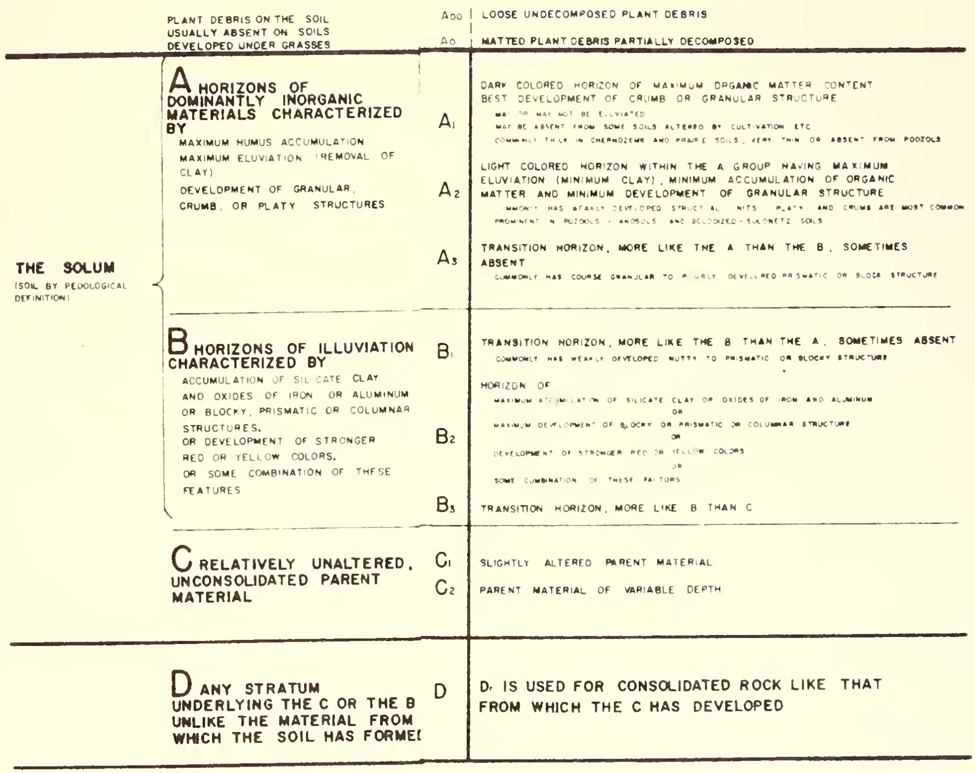

PLANT DEBRIS ON THE SOIL
USUALLY ABSENT ON SOILS
DEVELOPED UNDER GRASSES
A00
LOOSE UNDECOMPOSED PLANT DEBRIS
A0
MATTED PLANT DEBRIS PARTIALLY DECOMPOSED
THE SOLUM
(SOIL BY PEDOLOGICAL DEFINITION)
A HORIZONS OF DOMINANTLY INORGANIC MATERIALS CHARACTERIZED BY
MAXIMUM HUMUS ACCUMULATION
MAXIMUM ELUVIATION (REMOVAL OF CLAY)
DEVELOPMENT OF GRANULAR, CRUMB, OR PLATY STRUCTURES
A1
DARK COLORED HORIZON OF MAXIMUM ORGANIC MATTER CONTENT
BEST DEVELOPMENT OF CRUMB OR GRANULAR STRUCTURE
MAY OR MAY NOT BE ELUVIATED
MAY BE ABSENT FROM SOME SOILS ALTERED BY CULTIVATION ETC
COMMONLY THICK IN CHERNOZEMS AND PRAIRIE SOILS, VERY THIN OR ABSENT FROM PODZOLS
A2
LIGHT COLORED HORIZON WITHIN THE A GROUP HAVING MAXIMUM ELUVIATION (MINIMUM CLAY), MINIMUM ACCUMULATION OF ORGANIC MATTER AND MINIMUM DEVELOPMENT OF GRANULAR STRUCTURE
COMMONLY HAS WEAKLY DEVELOPED STRUCTURAL UNITS PLATY AND CRUMB ARE MOST COMMON
PROMINENT IN PODZOLS, PLANOSOLS AND SOLODIZED-SOLONETZ SOILS
A3
TRANSITION HORIZON, MORE LIKE THE A THAN THE B, SOMETIMES ABSENT
COMMONLY HAS COURSE GRANULAR TO POORLY DEVELLPED PRISMATIC OR BLOCK STRUCTURE
B HORIZONS OF ILLUVIATION CHARACTERIZED BY
ACCUMULATION OF SILICATE CLAY AND OXIDES OF IRON OR ALUMINUM
OR BLOCKY, PRISMATIC OR COLUMNAR STRUCTURES,
OR DEVELOPMENT OF STRONGER RED OR YELLOW COLORS.
OR SOME COMBINATION OF THESE FEATURES
B1
TRANSITION HORIZON, MORE LIKE THE B THAN THE A, SOMETIMES ABSENT
COMMONLY HAS WEAKLY DEVELOPED NUTTY TO PRISMATIC OR BLOCKY STRUCTURE
B2
HORIZON OF
MAXIMUM ACCUMULATION OF SILICATE CLAY OR OXIDES OF IRON AND ALUMINUM
OR
MAXIMUM DEVELOPMENT OF BLOCKY OR PRISMATIC OR COLUMNAR STRUCTURE
OR
DEVELOPMENT OF STRONGER RED OR YELLOW COLORS
OR
SOME COMBINATION OF THESE FACTORS
B3
TRANSITION HORIZON, MORE LIKE B THAN C
C RELATIVELY UNALTERED, UNCONSOLIDATED PARENT MATERIAL
C1
SLIGHTLY ALTERED PARENT MATERIAL
C2
PARENT MATERIAL OF VARIABLE DEPTH
D ANY STRATUM UNDERLYING THE C OR THE B UNLIKE THE MATERIAL FROM WHICH THE SOIL HAS FORMED
D
D, IS USED FOR CONSOLIDATED ROCK LIKE THAT FROM WHICH THE C HAS DEVELOPED

Figure 1. Theoretical Soil Profile.

The original parent material is modified by climate, time, topography, and vegetation as they influence biological activities, particularly the accumulation of organic matter, and the movement of soluble materials and suspended clay colloids by drainage. These factors develop the soil profile into the various horizons. The depth to which the profile development extends is dependent upon the intensity and duration of the forces active in the process of soil formation.

Pedological soils classification is based on the principle that like materials in like environments will form similar soil profiles. The variance of any of the principal factors of soil formation, however, will result in a different profile. From "The Engineer and Pedology," by James H. McLerran (1),

> "Soil is the result of soil-forming factors acting upon soil-forming materials. The soil-forming materials are the fragments of rocks and minerals that are produced mainly by physical weathering and changed somewhat by chemical weathering. Soil is produced from this parent material by the action of climate and organisms (particularly vegetation) conditioned by topography and the length of time of their effectiveness. There are to be considered, therefore, five principal factors that influence soil formation--parent material, climate, organisms, topography, and time. In areas where the inten-

> sity of chemical weathering is great because of warm temperature and high precipitation or old age, the tendency to retain the characteristics of the parent material is reduced. Even in such areas the texture of the parent material will control movement of water and, by so doing, exert an influence on the characteristics of the soil and the soil profile. (1)"

As shown in Figure 1, the fully developed profile consists of four horizons. The "A" horizon is the surface horizon and consists of the area of maximum accumulation of organic matter and eluviation, or removal of clay particles. In addition, it includes an area of transition of the "A" horizon to the "B". The "B" horizon is the area of maximum illuviation and is characterized by the accumulation of silicate clay and oxides of iron or aluminum. The structure is normally blocky, prismatic, or columnar. Stronger red or yellow colors are developed here. The "C" horizon is the relatively unaltered or unconsolidated parent material. The "D" horizon is any stratum underlying the "C" or "B" which is unlike the material from which the soil has formed.

Figure 1 shows a number of sub-horizons within each major horizon. It is not necessary that each of these be present in a given soil profile. Any combination of these may exist. In addition, it is not necessary that each horizon or sub-horizon contain all the characteristics listed.

There are exceptions to the formation of the profiles in certain soils. Notable among these are muck or peat soils and those formed from stratified water deposited materials. These soils do not have characteristics which fit this concept. Also, soils which develop under extremely wet or dry conditions do not develop profiles with distinct horizons.

The pedological system for soil classification is based on the soil profile and the natural processes involved in its development. The systems begin with a broad classification and proceed to break this down into progressively smaller groups which possess more and more similarities as the divisions become smaller.

It was found that soils possessing certain characteristics could be considered to be zonal and to develop in regions of broad climate and vegetative zones, provided that the topography, texture, and mineralogy of the soil forming material remained relatively constant. This classification is known as an "Order." Associated with the zonal soils are two other orders, the intrazonal and the azonal. The intrazonal soils are developed by modifications of the zonal climate and vegetation by local effects such as topography, drainage, or soil forming materials. This occurs where the factors which influence the development of the profile have not had time to modify the material.

The orders are divided into a number of suborders based on mineral content and climatic zones (2). For example, the intrazonal soils are subdivided into suborders called hydro-

morphic, halomorphic, and calcimorphic. These suborders are further divided into soils which develop similar profiles and which can be grouped together. These divisions are called the "Great Soil Groups." The great soil groups are divided into soil series. The soil series are given a name such as "Newton," "Jasper," or "Miami," which is usually associated with the place the soil was originally found.

The series is the basic classification. Slight variations in mineral content, drainage conditions, or slope may differentiate between series. The series is divided into soil types by adding modifiers which reflect the soil texture. The terms "sandy loam" or "silt loam" might be added to the Newton series to distinguish between two textural types. Minute features of topography have an effect on the soil types so these are further subdivided into phases by describing briefly the topography. Thus, "Newton sandy loam" might have both an "undulating phase" and a "wind eroded phase." The most common unit on agricultural soil maps is the phase. The pedological classification system is illustrated graphically by Figure 2.

In order to illustrate the significance of the information contained in soil survey reports, the following description of classification procedures is quoted from the "Soil Survey, Newton County, Indiana" (3):

> "Soil surveying consists of the examining, classifying, and mapping of soils in the field. The soil scientist walks over the area at intervals not more

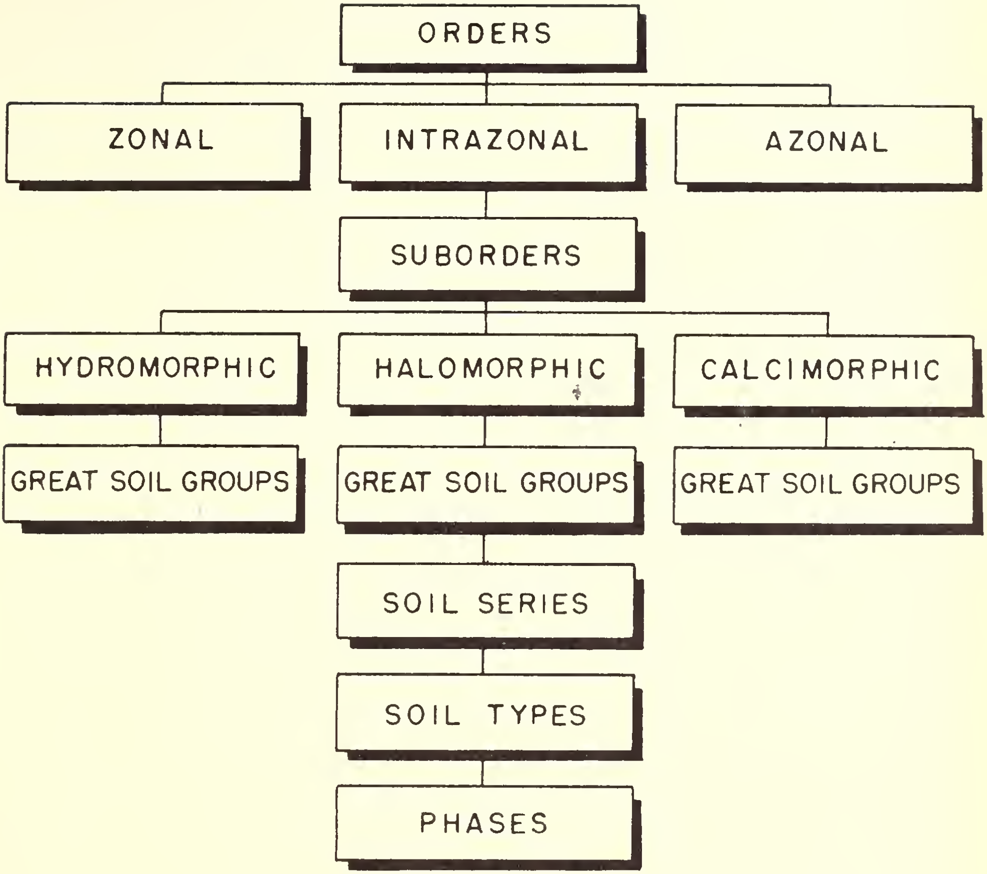


Figure 2. Agricultural Soil Classification System.

than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each boring or hole shows the soil to consist of several distinctly different layers, called horizons, which collectively are known as the soil profile. Each of these layers is studied carefully for the physical and chemical characteristics that affect plant growth.

"The color of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration.

"Texture--the content of sand, silt, and clay in each layer--is determined by the feel of the soil when rubbed between the fingers and is checked by mechanical analysis in the laboratory. Texture determines to a considerable extent the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizers will be held by the soil in forms available to plants or will be leached out, and the difficulty or ease of cultivating the soil.

"Soil structure, or granulation, and the number of pores or open spaces between soil

> particles determine the permeability or perviousness of the soil, and consequently, the ease with which plant roots penetrate the soil and water enters it. Consistence, or the tendency of the soil to crumble or to stick together, determines the degree of difficulty that will be encountered in keeping the soil open and porous under cultivation. Consistence covers such soil characteristics as hardness, friability, plasticity, stickiness, compactness, toughness, and cementation" (3).

As the engineer becomes more familiar with the science of pedology and the procedures for classifying soils, it becomes apparent that there are a number of ways in which this information can be of value. There are limitations to its use, certainly, but it does offer opportunities for gaining the areal significance for the results of engineering tests, for reconnainssance, to locate construction materials, and to correlate structural performance with soil types. It is apparent that the soil survey helps to reduce field work to a minimum, thereby effecting a saving in cost and time involved in soil exploration for any type of construction, and particularly for highway construction. It reduces sampling and testing to the minimum necessary for correlation, and allows the concentration of manpower and effort in areas where poor soil conditions are apparent from the Soil Survey Report.

# CHAPTER II

# NATURAL SETTING

## Introduction

This chapter deals with the physiography and geology of Newton County. The information contained herein is a summary of the available literature.

A knowledge of the physiography and geology of the area is very important in a study of this type. From this literature survey, the engineer gains an insight into the general types and the origin of the various materials which will be encountered during the process of preparing an engineering soils map. The detailed information needed for the compilation of the map does not result from this study of physiographic and geologic literature, but is obtained from the agricultural soils data and a study of the airphoto patterns. However, problems as to grouping of agricultural soil types and interpretation of the airphoto pattern will be more accurately solved if the engineer has a general knowledge of the occurrence and distribution of materials. The physiography and geology then, acts as a tool giving the engineer a background upon which to base his judgement in solving the various problems which come up during the course of the study.

## Physiography

Newton County, Indiana, lies within the Central Lowland Province as defined by Lobeck (4). About nine-tenths of the county lies within the Eastern Lake Section; the remainder is

situated in the Till Plains Section. On a regional basis, there is no sharp dividing line between these two sections. However, in Newton County, the division is readily apparent and can be determined within reasonable limits.

The average elevation of the county is about 650 feet above sea level. The highest point in the county has an elevation of about 770 feet and the lowest point, about 620 feet (5).

On a local basis, the county can be divided, as shown in Figure 3, into four main physiographic sections; the Kankakee Basin, the Marseilles Moraine, the Iroquois Lacustrine section, and the Tipton Till Plain.

## Kankakee Basin

The Kankakee Basin parallels the Kankakee River, the northern county boundary, and makes up, roughly, the northern one-half of the county. Sand dunes and ridges occur irregularly throughout this area. These features consist of wind blown materials and vary in height from 1 to 30 feet or more. The ridges are oriented in a northwest-southeast direction and are the wind eroded remains of former beach ridges formed by the receding action of an old glacial lake. Many of the dunes are cresent-shaped and are still active today.

Much of this area was formerly a swamp and was covered by water. Beaver Lake, covering about 25 square miles, was the remnant of an old glacial lake. Both the swamp and the lake have been drained and most of the area is now available

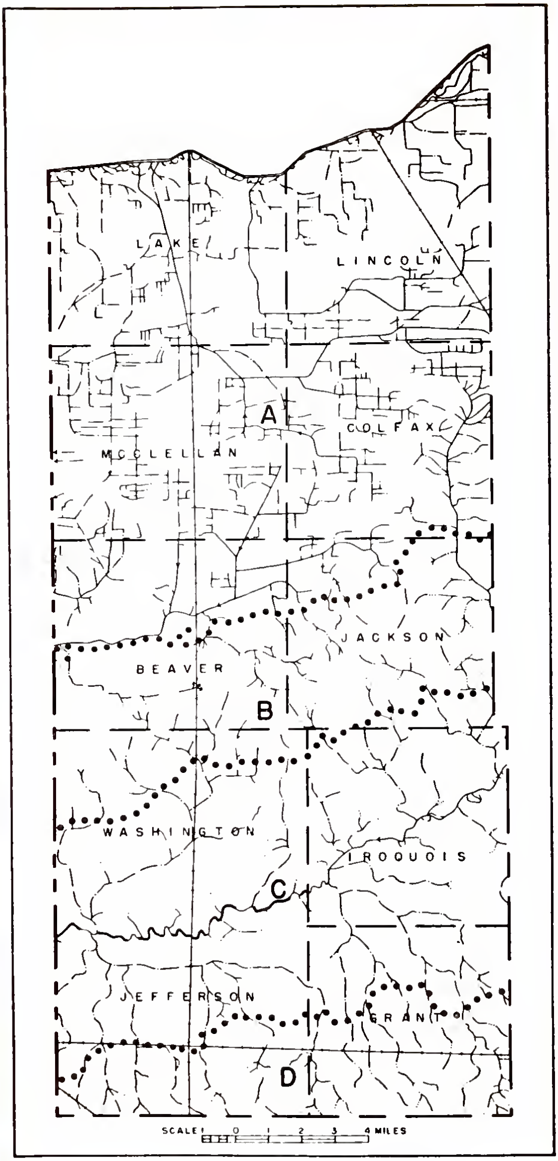


Figure 3. Physiographic and Drainage Areas of Newton County (3).
A. Kankakee Basin B. Marseilles Moraine
C. Iroquois Section D. Tipton Till Plain

for farming.

Local relief is slight. The sand dunes and ridges are the primary relief features. Drainage is predominantly artificial and consists of both open ditches and tile drains. The coarser sandy soils drain internally where the water table has been lowered by these artificial drains.

## Marseilles Moraine

The Marseilles Moraine section, about 2½ miles wide, is oriented in a northeast-southwest direction and extends completely across the county. It is directly south of the Kankakee Basin. Generally speaking, this area is made up of unstratified glacial deposits of sand, silt, and clay. However, many small areas may be stratified. This is evidence of water deposition and the materials are similar to those of the adjacent Iroquois Lacustrine section (3).

Sand dunes occur along the northern boundary and the topography is undulating to rolling. This moraine has a long gradual slope on the north, rising 20 to 40 feet in about 2 miles. On the south the descent is rather abrupt and the fall is about 40 feet in less than a mile. Sloughs and shallow basins are found interspaced among the knolls and ridges. Many of these are enclosed on all sides and contain considerable organic matter.

## Iroquois Lacustrine Section

The Iroquois section is an undulating to nearly level plain consisting of stratified sand, silt, and clay, with a

small amount of gravel in some places. This material varies in thickness from a few inches to several feet and overlies an unstratified, undulating till plain similar to the Tipton Till Plain found to the south. Adjacent to the Iroquois River and its tributaries there are narrow, steep slopes. Occasionally, low aeolian sand ridges rise above the general level of the land. On the east, the material consists of a thin mantle of sand and silt over heavy lacustrine clay (5).

### Tipton Till Plain

The Tipton Till Plain is small in areal extent and includes only the extreme southern part of the county. It varies from about 1 mile wide in the western part of the county to about 3 miles wide in the eastern part. The topography is undulating to gently rolling, and narrow, steep slopes occur along the drainage ways. The predominant material is an unassorted glacial till and varies in thickness from 1 foot to 100 feet or more. The underlying bedrock is exposed at the stone quarry just east of Kentland, and it also outcrops along the valley of a small stream south of Goodland.

## Geology

### Bedrock Geology

Information concerning the bedrock geology of Newton County is rather limited. The surface and near surface bedrocks are primarily of Devonian and Silurian Age. Outcrops of bedrock are found only in the southern part of the county.

These outcrops appear at the quarry east of Kentland and in a small stream valley southeast of Goodland. The northern part of the county is underlain by Niagara Limestone of Silurian age and the major portion of the southern part is underlain by Devonian groups (6).

From the records of deep wells and outcrops, the following geological formations have been identified (6):

| | |
|---|---|
| Quaternary | Clays, Sands (Recent)<br>Clays, Sands, and Gravel (Pleistocene) |
| Pennsylvanian | Sandstone (Mansfield) |
| Mississippian | Shales, Limestone (Borden) |
| Devonian | Shales (New Albany)<br>Limestones (Sellersburg)<br>Sandstone (Pendleton) |
| Silurian | Limestone (Huntington, Liston Creek, Brassfield)<br>Shale (Mississinewa) |
| Ordovician | Limestone, Shale (Richmond-Eden)<br>Limestone (Trenton) |

The lack of information on the bedrock geology is due primarily to the deep deposits of glacial drift and associated lacustrine materials which cover almost all of the county.

## Glacial Geology

From an engineering standpoint, the bedrock geology of Newton County is of academic interest only, except for the quarry located in the southern part of the county. The importance of the glacial geology of this area greatly exceeds that of the bedrock geology.

Glaciologists have been able to piece together a wealth of information concerning the several different Ice Ages. The Glacial Ages, particularly the more recent ones, left an abundance of evidence which glaciologists have been able to analyze. From this information they have been able to determine with a high degree of accuracy the history of the Pleistocene, or Ice Age.

It has been established that the glaciation of Wisconsin Age progressed in four different advances and recessions. The Tazewell advance, early Wisconsin, is responsible for the Till Plain deposit in the southern part of Newton County. This material, composed of unstratified boulders, gravel, sand, silt, and clay, was deposited by the ice. The flat topography and the unassorted nature of the deposits indicate that this material was deposited in place.

The Marseilles Moraine, to the north of the Till Plain, suggests that here the glacier stopped receding momentarily and formed what is known as a recessional moraine. This deposit is characterized by its elevation above the surrounding countryside and its rolling topography. Glaciologists have established that these deposits resulted from the momentary balance of the melting of the ice and a renewed advance of the ice sheet. As the ice melted, the melt waters deposited the glacial debris at the southern extremity of the ice sheet, causing the development of a thicker deposit of till material in its characteristic state; hence, the name recessional moraine has been applied to this type deposit.

Between the Marseilles Moraine and the Tipton Till Plain is an area of glaciofluvial outwash. This material was deposited over material similar to that of the Tipton Till Plain and is somewhat stratified. During the period of inactivity of the glacier at the site of the Marseilles Moraine, much of its load was carried beyond the extremities of the ice and deposited in what is now known as the Iroquois Lacustrine Section.

During glacial times, the Kankakee River was blocked by glacial debris near its junction with the Illinois River (7). This caused the Kankakee Basin to be flooded by the melt waters of the glacier. This obstruction, however, must have been only partial since the sediments in this area are clean sands with some silts rather than the fine grained soils typical of most lacustrine deposits. This is indicative of deposition by flowing water (8).

The "Manual for the Airphoto Interpretation of Soils and Rocks for Engineering Uses," (8), very ably describes this area as follows:

> "The Kankakee Basin may be regarded as a huge settling basin rather than a true lakebed. The flow of water must have been steady and sufficiently rapid to carry away all the soil fines and leave only clean beds of sand interbedded with some silt. The velocity of water flow must have wasted itself in the outwash plains proper, northeast of the basin, just below the Valparaiso Moraine in Porter,

LaPorte, and St. Joseph counties. This would account for the absence of gravel particles in the basin itself. Airphoto studies, verified by field checking, show that the gravel of the indicated outwash plains gradually grades into sand at the border lines. The thickness of the sand in the basin varies according to the irregularities over which it was spread, but a depth of 10 feet seems to be a good average for the entire area (8)."

# CHAPTER III

# PROCEDURE FOR PREPARATION OF ENGINEERING SOILS MAPS

## Introduction

The purpose of this chapter is to present what appears to be the most accurate and economical way to prepare engineering soils maps utilizing agricultural soils data as the primary source of information and supplementing this by the use of airphotos. The procedures described in this chapter were used in the preparation of an engineering soils map of Newton County. Several methods of attacking the problem were tried initially, but the best procedure seems to be a straight forward application of airphotos to the engineering interpretation of the agricultural soils map and related data.

The first problem encountered in this study was the bridging of the gap between the pedologist and the engineer. It was necessary to study pedological literature in order to become familiar with pedological concepts of soils classification, terminology, and mapping procedures. Chapter I of this study outlines this briefly, but it should be supplemented by a study of pedological literature prior to using the procedure outlined in this study. The sequence followed is that found to be most useful and which avoids unnecessary repetition.

## General Airphoto Study

Airphotos were used as the medium through which to become familiar with the area under study. A mosiac was prepared

for the entire county using the Department of Agriculture photography. This photography is at a scale of approximately 1:20,000. The mosiac was rather large, but not so unweildly as to be bothersome or clumsy to use.

First, an overall perspective of the area was gained through study of the small scale county index sheet. Major variations noticed on the index sheet were noted and studied more closely on the 1:20,000 mosiac.

Secondly, the mosiac was studied in stereo and the variations in the airphoto pattern were noted. The county was divided into sections on the basis of topography and major changes in the airphoto pattern. These boundaries correspond to the major physiographic boundaries and were later used as areas for detailed study.

## Literature Study

Existing literature, principally that concerned with geology and physiography, was reviewed in order to gain an insight into the natural setting of the area. In addition, well logs and borings were studied in an effort to supplement geologic and physiographic literature. This is an important phase of a study of this type. Information of a general nature, contained in the literature, can be exploited and given additional significance through the use of airphotos.

## Detailed Airphoto Analysis

A detailed airphoto study was accomplished prior to

performing an engineering evaluation of the agricultural soils data in order to gain an insight into the various engineering materials which would be encountered. This greatly facilitated the study of the agricultural data.

Minute variations in the airphoto pattern were found to be reflected on the agricultural map by types and phases within a series, if not by different series. This allowed detailed information to be gained when the airphoto analysis was correlated with the agricultural soils data.

## Study of Agricultural Soils Data

The information contained in the Agricultural Soil Survey Reports is very detailed and written, of course, for the agronomist. The major problem confronting the engineer is simply one of interpretation of pedological data and applying it to engineering.

During this phase of the study, both the agricultural soils map and the soils data contained in the accompanying Soil Survey Report were studied in detail. The discussion of typical profiles, found in this report, was extremely helpful, and proved to be very accurate. These profiles were considered from an engineering standpoint and changed to a form more easily used by the engineer. The results of this are found in Appendix A where typical profiles of the soil series appearing in Newton County are illustrated.

The agricultural soils map was used to draw general engineering soil borders by grouping the soil series possessing

similar characteristics when considered from the standpoint of engineering.

## Correlation of Airphoto Patterns with Agricultural Soils Data

This phase of the study correlated the detailed information gained from the airphoto analysis and the study of the agricultural soils data. Typical soil situations were studied. On the basis of the airphoto pattern, soil series were grouped with regard to their engineering characteristics. From these groupings, the basic mapping units were obtained.

Previous to this study, the Staff of the Airphoto Laboratory had prepared a group of symbols representing the majority of engineering soil materials found in Indiana. Where possible, the grouping of the various soil series were based on these materials. In most instances, this presented no problem.

## Field Investigation

Field investigation, sampling, and laboratory testing were kept at a minimum during the course of this study. Field work was used to determine groupings of some soil series which, from the information available, did not readily adapt themselves to grouping.

In addition, field investigation was used to check the accuracy of the resulting engineering soils map and to provide liquid and plastic limit data to aid in preparing engineering profiles.

## Preparation of the Base Map

The scale of 1 inch equals 1 mile was previously chosen for the engineering soils maps of Indiana. This scale has proved to be very practical in working with airphotos and with the agricultural maps.

Most of the recent agricultural maps have been published at a scale of 1 inch equals 2 miles. These maps readily adapt themselves to a fifty percent photographic reduction. When reduced to a scale of 1 inch equals one mile, they provide an excellent base for engineering soils maps. Small errors are introduced during the process of reduction due to the optical characteristics of the camera lens and to shrinkage and expansion from temperature and moisture variations. These, however, are insignificant and may be disregarded.

The draft copy of the engineering soils map was prepared in pencil on tracing paper. This was later traced in ink on linen and the marginal data added.

# CHAPTER IV

# AIRPHOTO ANALYSIS AND CORRELATION WITH AGRICULTURAL SOILS DATA

## Introduction

This chapter is concerned with an evaluation from airphotos, field investigation, and agricultural soils data of the surface materials occurring in Newton County. This evaluation was divided into four sections and each section discusses one of the four physiographic areas in Newton County.

Each section is discussed from the standpoint of airphoto interpretation and then the engineering significance of the agricultural soils data is considered. A final discussion then correlates the airphoto pattern and the agricultural soils data and groups the soils into similar materials which form the basic engineering soils mapping units.

In the airphoto study, typical soil situations are analyzed with regard to their relationships to one another from an engineering standpoint. Essentially the same process is involved in the evaluation of the agricultural soils data except for the medium through which it is accomplished. The final correlation between the airphoto patterns and the agricultural soils data considers both from the standpoint of engineering and groups the various soils into materials which form the mapping units on the engineering soils map.

## Kankakee Basin

### Airphoto Analysis

The overall land form of this section is that of a low plain broken by knolls and ridges which rise above the surrounding area. Some of these relief features exhibit characteristics of wind erosion while others do not. The dune shaped knolls which are the result of wind action can be distinguished, in most instances, by their shape and slope. (See Figure 4.) The ridges in this area have been identified as beach ridges. They are oriented in a generally northwest-southeast direction and are roughly parallel. These ridges are very long in proportion to their width.

The Kankakee River is the main drainage feature in this area and it forms the northern boundary of the county. Old meanders and oxbow lakes stand out on the airphotos and indicate old abandoned channels. The main channel has been straightened in some places by artificial means and appears as a series of straight ditches connected by gentle, controlled curves. Numerous artificial drainage ways carry surface runoff to the river. Tile drains can also be identified from the airphotos. The artificial drainage has a rectangular pattern indicative of man-made features.

The absence of gullies or other surface drainage features is significant in that it indicates that the soils are well drained internally and that little drainage is accomplished through surface runoff. The extensive man-made drainage is

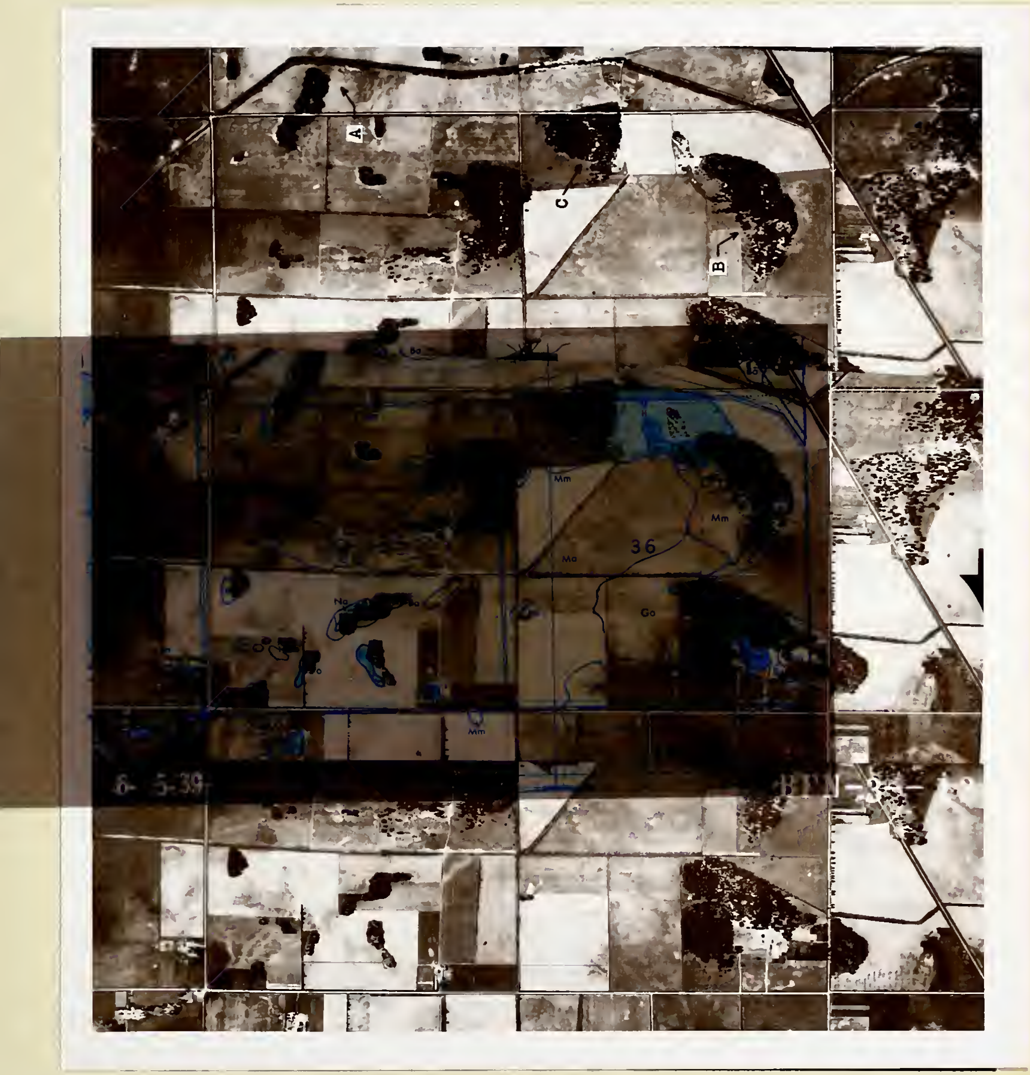
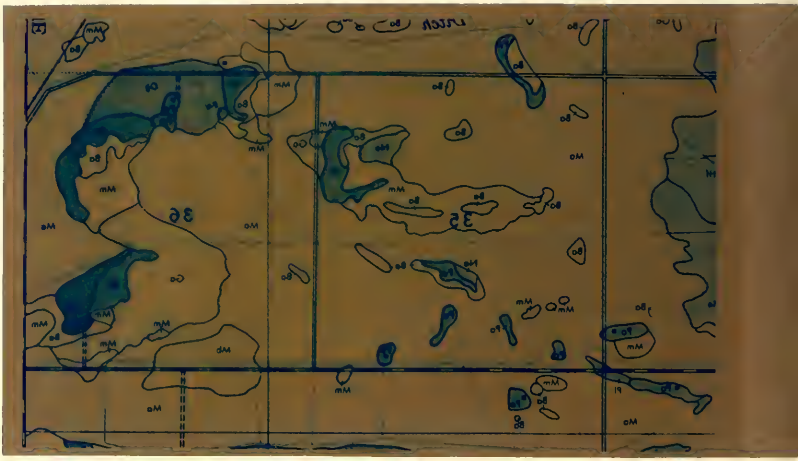


Figure 4. Soil Patterns of the Kankakee Basin. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



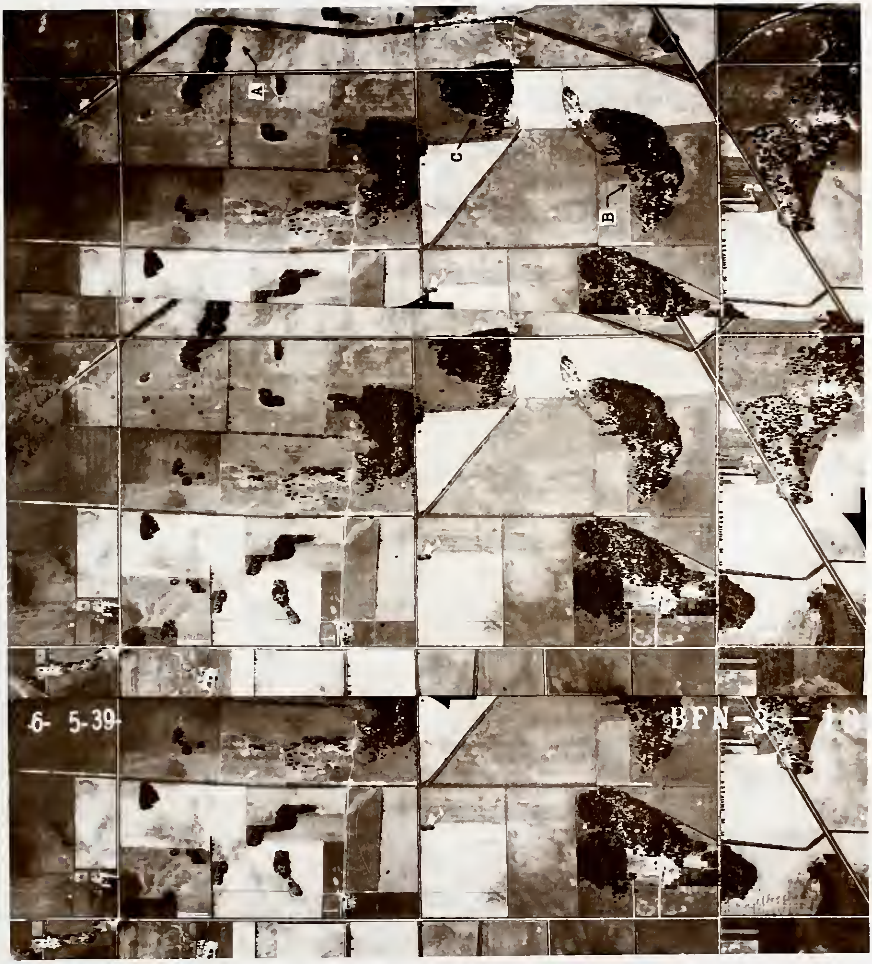


Figure 4. Soil Patterns of the Kankakee Basin.
This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

evidence of adverse moisture conditions and it can be inferred that this results from an extremely high ground water table. Figure 4 illustrates the absence of natural gullies and an attempt to lower the water table through artificial drainage.

The wide variations in photo tone support the inference that the ground water table is very high. In areas where artificial drainage appears, the tones are generally light as compared with the areas where no artificial drainage is found. The letter "A" in Figure 4 identifies this condition. Quite a number of depressional areas have a very dark gray to almost black tone. Artificial drainage has not affected the tone of these areas to any great extent.

Much of the land is under cultivation and natural vegetation is lacking. However, many of the dune and ridge features have been left to natural vegetation, apparently in an effort to halt wind erosion. This is evident from Figure 4. The shape and slope of the major relief features are indicative of sand dunes and beach ridges. This is supported by the very light photo tones and the absence of surface drainage features. Even on the steeper slopes of the dunes and ridges, no gullies have developed.

The wide variation in photo tone reflects the texture of the soil, the moisture content, and the organic content. The dark depressional areas are generally at the lowest elevations. The dark tones of these areas can be accounted for by the presence of both organic matter and high moisture content, and indicates that these deposits may be muck or peat.

The extensive man-made drainage ditches and use of tile drains indicates that drainage is a problem and supports other pattern elements in this respect. The other pattern elements indicate that this material is granular, therefore the porosity of the soil would not be a consideration. This means then, that the water table is very high and it is necessary to provide artificial drainage to lower it.

The low area adjacent to the river is characterized by natural vegetation, current scars, dark tones, and old stream meanders as evidenced by the numerous oxbow lakes in the area. This is indicative of an area subject to frequent flooding. This pattern infers that the soil textures are somewhat finer than that of the plain proper and that the overall organic content is somewhat higher.

The overall pattern of the Kankakee Basin indicates a predominantly granular soil. The dark depressional areas are high in organic content and are probably muck. The sand dunes, since they are the result of wind action, are probably uniform in texture as are the beach ridges, though not to such an extent as the dunes. Indications are that the sand deposits are quite deep, but the possibly exists that they overlie a finer textured soil, probably of glacial origin.

## Engineering Significance of Agricultural Soils Data

A study of the profiles and related data given in the Soil Survey Report indicates that the soil series occurring

in the Kankakee Basin may be grouped, from the standpoint of engineering materials, as follows:

Group I

Alida (Ac)
Berrien (Ba,b,c)
Bridgman (Bd)
Conrad (Ck)
Dillon (Df,g)
Granby (Ga,c)
Maumee (Ma,b,d,e)
Morocco (Ml,m)
Newton (Na,b)
Plainfield (Pl,m,n,o,p,r)
Weiss (Wc,d)

Group II

Granby (Gb)
Houghton (Hd,f,g)
Maumee (Mc)
Wooten (We,f)

Group III

Edwards (Ea,b,c)
Houghton (He)

Group IV

Griffin (Gd,e,f)

Group V

Della (De)

The symbols appearing after each of the above soil series indicate the type and/or phase of the series appearing in each group. It should be noted that types and/or phases of some soils appear in two groups. This same procedure of symbolization is used in other discussions in this chapter.

The soil series comprising Group I are deep deposits of relatively clean sands. The organic content of the topsoil is quite variable. All of these soils possess excellent internal drainage characteristics. However, the extremely high ground water table in the Kankakee Basin keeps these materials in a very wet condition except where the ground water table has been lowered by artificial means. These

sands were originally water deposited, but wind action has reworked many of them into dune forms.

Profiles of these soils are quite similar. The main differences are in organic content, depth of topsoil, and ground water conditions. A discussion of typical profiles is given in Appendix A. Reference to the "Soil Survey, Newton County," will provide the engineer with detailed information concerning the various types and phases of these soils.

Group II is made up of organic sands. These sand deposits are very deep and are similar in all respects to those of Group I except for the organic material occurring at various depths. Phases of the Granby and the Maumee are underlain by a strata of muck. This usually occurs at a depth of from 14 to 36 inches, and varies in thickness from 6 to 24 inches. Of the four phases of Houghton muck found in Newton County, three are shallow deposits of muck over deep deposits of sand and are included in Group II. The Wooten series also has a strata of mucky material, but it occurs generally at a greater depth than does that in the Granby and Maumee. This muck layer occurs at about 3 feet in the Wooten and averages about 1 foot in thickness.

Group III, the Houghton and Edwards series, are deep deposits of muck, peat, and marl. One phase of the Houghton is in this group. It is a very deep muck deposit. The Edwards soils are rather shallow deposits of muck, about 18 inches, over deep deposits of marl. From an engineering standpoint, this marl can be grouped with the muck.

The Griffin series, Group IV, is a floodplain soil found along the Kankakee River. The texture is quite variable, ranging from a sandy silt to clay. This soil is subject to frequent flooding and is generally in a poorly drained condition. Much of the area of Griffin soil is cut up by old channels, now filled. This soil contains a high percentage of fines in its profile, and the percentage of sand size material varies considerably. From the agricultural soils map, the areas of high and low sand content can be distinguished since they are mapped as different types of the Griffin series. In general, this area is low and wet. The old stream channels present a problem in that they cannot be crossed, as a rule, without a bridge. For engineering purposes, this area is one to be avoided, principally because of the flooding problem. Highway construction across this area would necessitate bridging and high fills.

Group V, the Della series, is a very poorly drained clay soil. The topsoil is high in organic content and overlies a subsoil varying in texture from a sandy clay to a silty clay. The parent material is a clay soil, interstratified with thin layers of sand and silt. For engineering uses, this soil would give poor performance.

## Correlation of Airphoto Patterns with Agricultural Soils Data

Figure 4 is a stereotriplicate showing both dune areas and low lying plain. The dunes stand out when viewed in stereo. The size, shape, and slope of these dunes varies considerably.

The windward sides have more gentle slopes than do the leeward sides. Note "B" and "C" in Figure 4. The dunes have been left to natural vegetation and only a few attempts have been made to cultivate crops on them. This is in an effort to stop wind erosion. Where natural tones of these dunes are exposed by an absence of vegetation or in road cuts, it is a light grey to white. These dune sands are predominantly the Plainfield soils in the higher topographic situations. The Berrien and Newton series occupy the lower slopes just above the plain. Photo tones in this plain area vary from light to dark and indicate the various types and phases of the low lying Granby and Maumee series.

Figure 5 is a sterectriplicate covering an area with somewhat different characteristics in that muck and peat deposits are found along with areas which are practically under water where natural drainage prevails. Areas marked "A" and "B" are muck and peat deposits. It can be seen that these are low areas of dark to very dark tones. Drainage ditches do very little to lighten the overall tone. Where the Houghton mucks are underlain by sand, the drainage characteristics create a lighter photo tone and man-made drainage is bordered by streaks of light tone indicating a lower moisture content by virtue of seepage into the drainage ditches.

In Figure 5, the Edwards soil, area "B", is a muck overlying marl. These materials are rather hard to distinguish from the transitional Houghton soils on the airphotos, but comparison with the soils map readily differentiates between

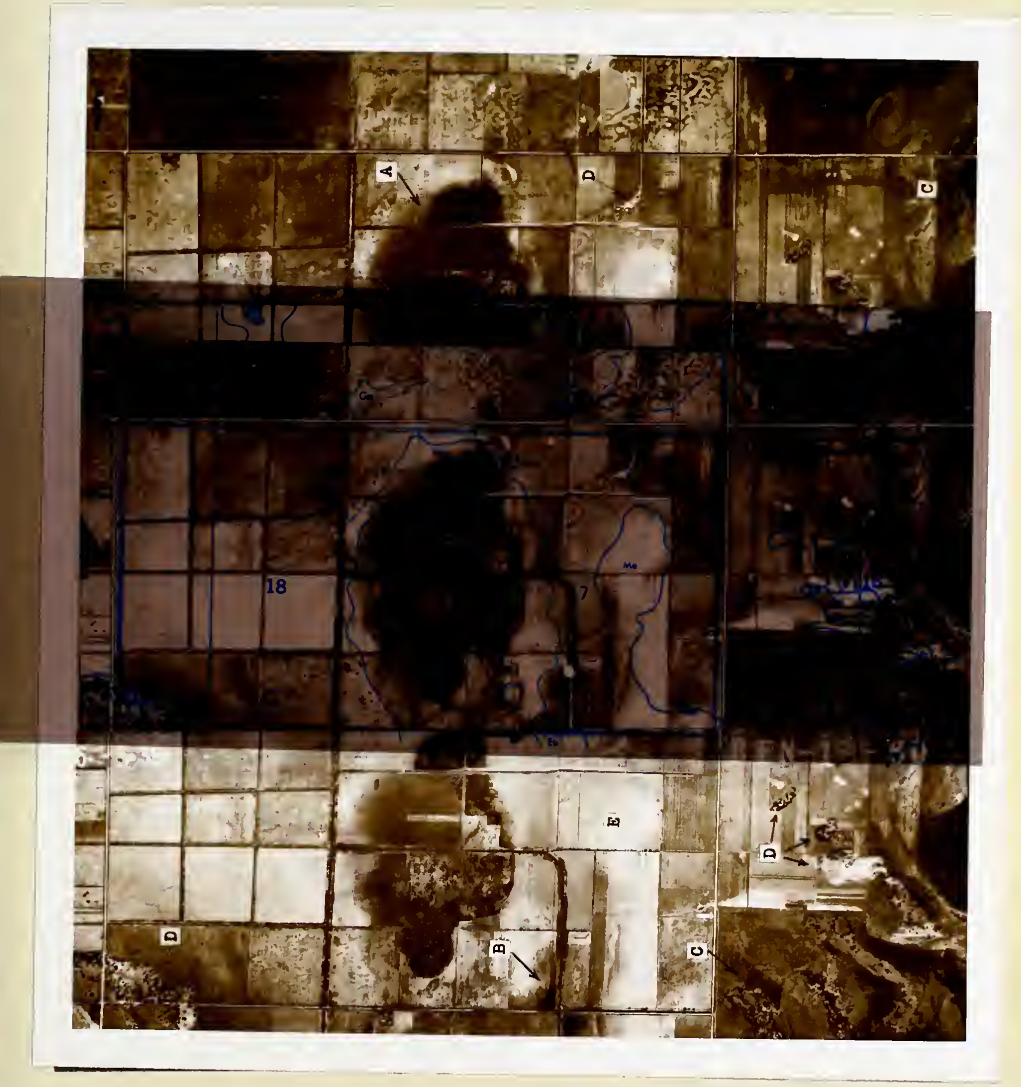
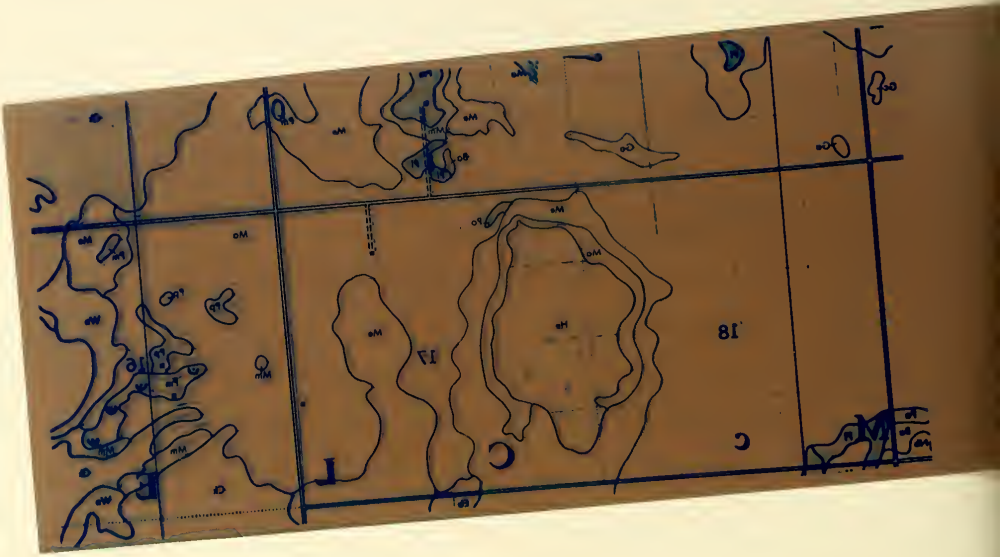


Figure 5. Soil Patterns of the Kankakee Basin. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



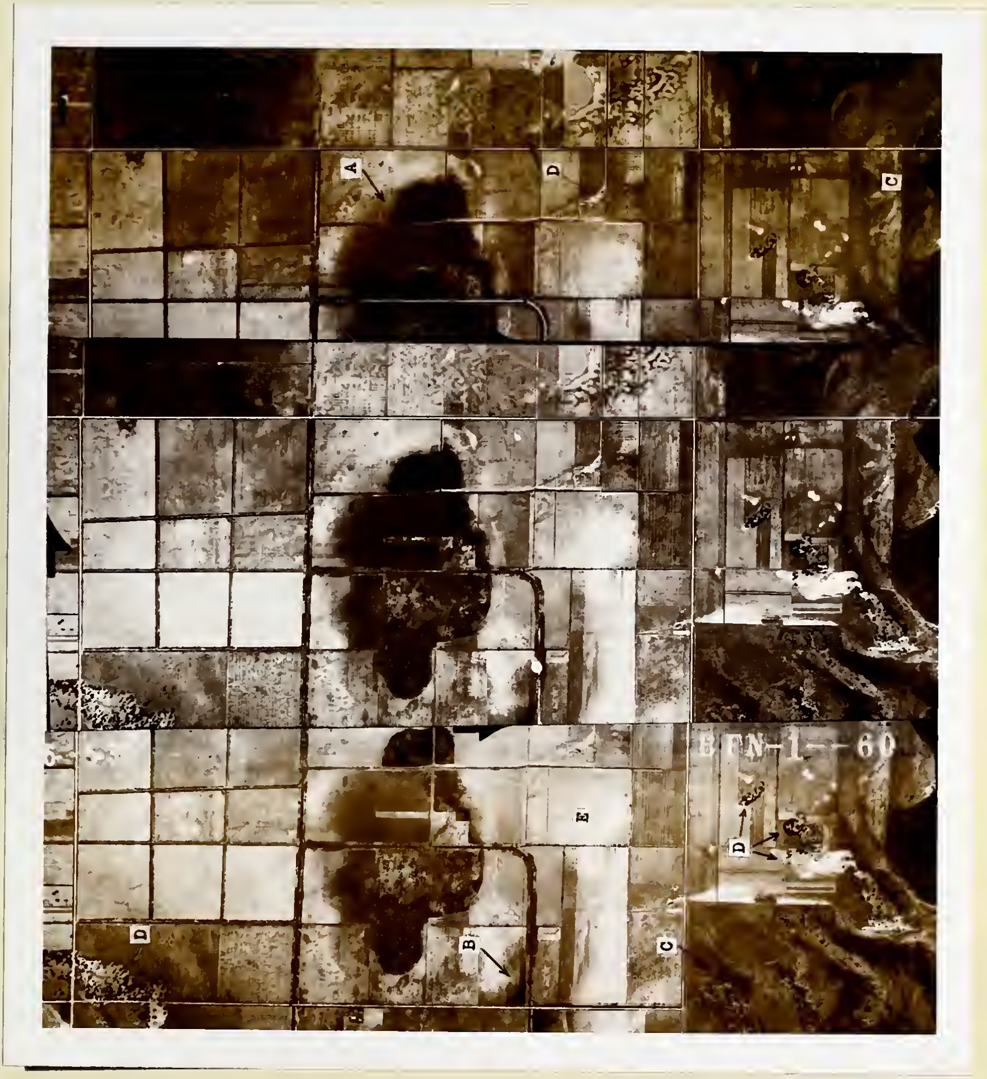


Figure 5. Soil Patterns of the Kankakee Basin.
This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

the two.

The areas marked "C" in Figure 5 are those in which an extremely high ground water table prevails. These soils are essentially under water where no artificial drainage has been provided. They are characterized by dark to very dark tones and a "blotchy" appearance, created by the variations in tone. The very high ground water table has retarded the development of the soil profile and organic content, even in the topsoil, is somewhat low. This soil is the Conrad series. Where the problem of the water table can be handled, this soil is an excellent engineering material.

Areas "D" in Figure 5 are Plainfield and associated soils occurring at higher elevations. These have been discussed in connection with Figure 4, as have the Maumees, area "E".

The overlay in Figure 5 is a portion of the agricultural soils map to the same scale as the airphotos and it is inserted for comparison purposes. The major soil borders can be traced on the airphoto by correlating changes in elevation and tone with the soil borders appearing on the overlay.

The materials which appear on the engineering soils map attached to this report are the groups of agricultural soil series which are given in this chapter. It should be noted that the Group II soils have been given a symbol on the engineering soils map which signifys an organic topsoil. This is done merely to call attention to these soils since they contain a strata of muck in the subsoil. The topsoil in these areas does not necessarily contain more organic

material than those of Group I.

Due to scale limitations and one color reproduction, it was not possible to prepare an engineering soils map reflecting the variations in texture which are shown on the agricultural soils map, but reference to this map will give more detailed textural information.

## Marseilles Moraine

### Airphoto Analysis

The Marseilles Moraine extends across the county and separates the Kankakee Basin from the Iroquois section. The topography is rolling and it is the major topographic feature in the county though relief is not too great, only about 40 feet above the adjacent areas. The south slope is more abrupt than the northern slope.

The drainage pattern formed on this moraine is the dendritic type, dense along the central ridge portion and becoming more sparse on the slopes. Drainage is away from the ridge line to the Iroquois River to the south and to the Kankakee River to the north. The higher central portion, or ridge line, is outlined by the drainage pattern. A considerable number of small kettle holes are scattered throughout the moraine and many of them have small gully systems terminating in them. These kettles are very dark in tone due both to vegetation and moisture, and act as settling basins for runoff from the surrounding areas. The overall drainage pattern is indicative of a fine textured material in that

it is rather densely developed. The most significant erosional feature is this dense gully development. In some instances, particularly near the borders of the moraine, the natural gully pattern has been altered by ditching operations. The predominant gully shape and gradient is broad and shallow, with a gentle gradient; however, a few gullies are narrow and deep in proportion to their width. Many gullies end in kettles, or undrained depressional areas. The letter "A" in Figure 6 identifies a characteristic gully. It is indicative of fine grained texture. "B" is a narrow and rather deep gully which has probably been altered by excavation although the airphoto fails to show such evidence. "C" identifies an artificial drainage ditch. A kettle hole is indicated by "D". The group of kettles near the center of the illustration is evidence of a more granular material.

Photo tones reflect moisture and vegetative conditions and are very closely related to the drainage pattern and to gully shape and gradient. Tones vary from very light to very dark, almost black areas. The kettles, "D" in Figure 6, are very dark. The gullies appear as broad, dark bands indicating the presence of moisture and organic material. The areas of light tone occur on knolls and hills and on the steeper slopes away from the gullies. These are the better drained areas. The tonal variations typical of this moraine are those appearing in the area identified by "E" in Figure 6. Generally speaking, this type of variation is indicative of a predominantly fine grained material. Tonal variations

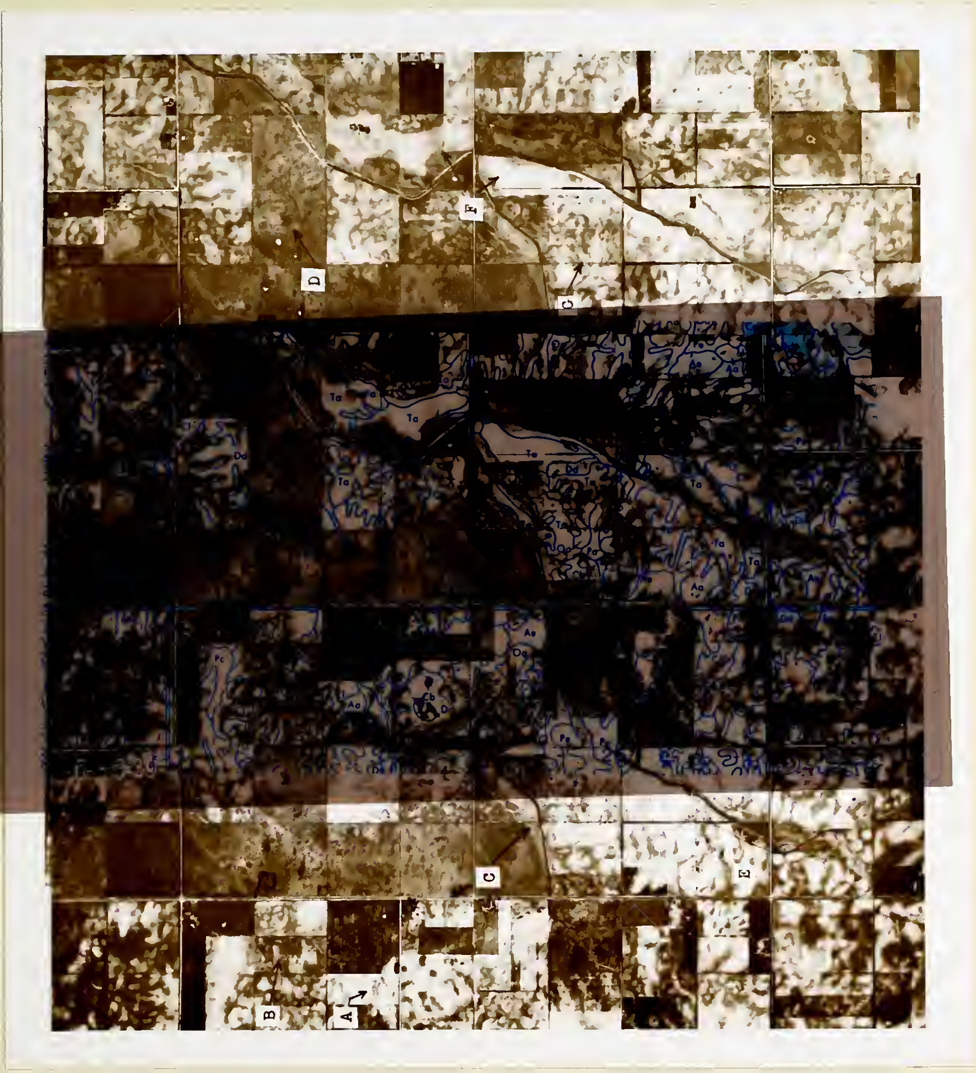
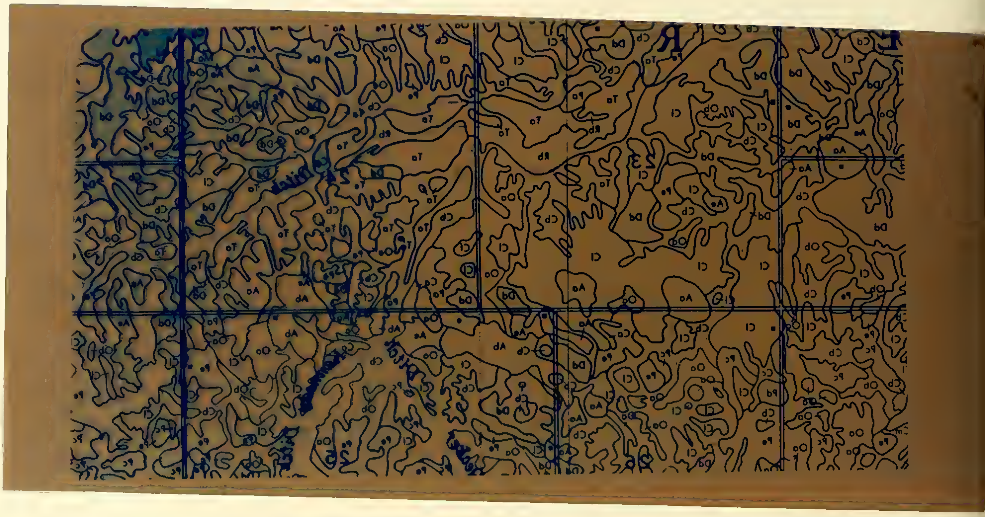


Figure 6. Soil Patterns of the Marseilles Moraine. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



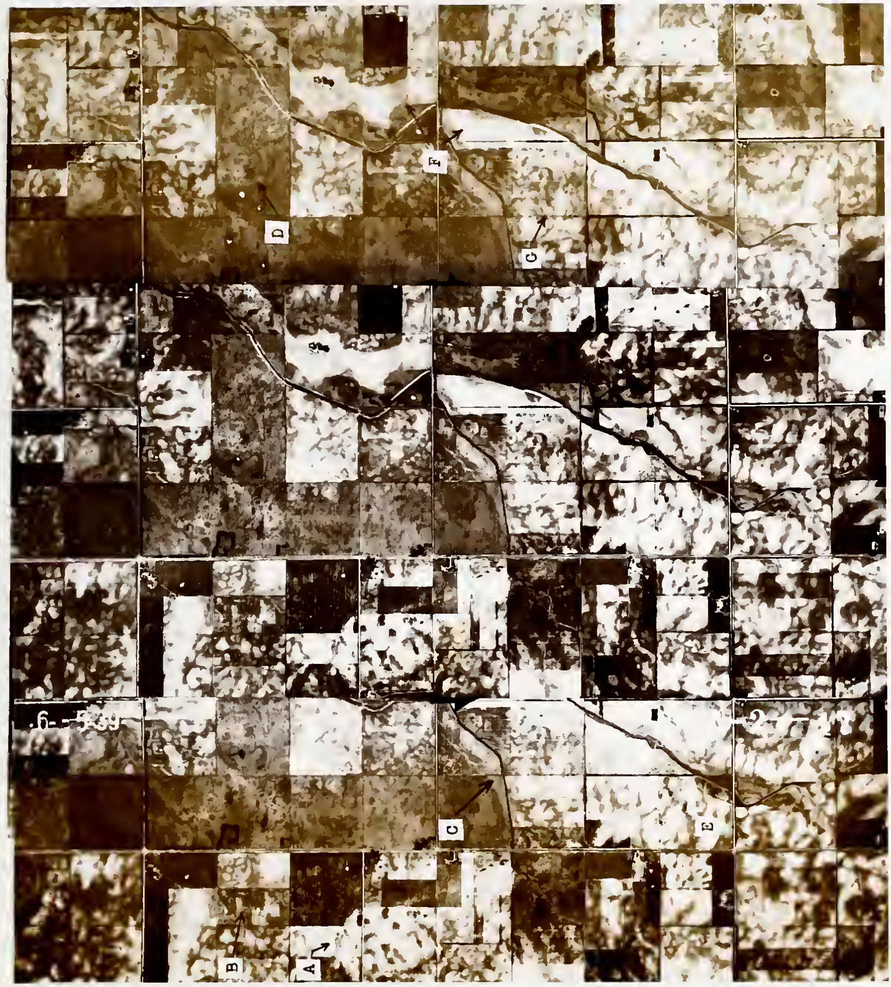


Figure 6. Soil Patterns of the Marseilles Moraine. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

along the ditch, "F" in Figure 6, reflect a different situation. These variations show evidence of the effects of flowing water. The mottled light and dark tones have been altered to show characteristics of water deposition. It appears that this is an old channel which has been filled. The finer mottled effect, most noticable in the area marked "G", is indicative of granular material. A small gravel pit has been opened in this area since these airphotos were taken. This gravel is overlain by 8 to 12 feet of fine grained alluvial materials and peat. The gravel occurs in relatively thin beds, usually a maximum of 3 or 4 feet in thickness. The gravel particles are sub-rounded to rounded, characteristic of water deposition.

Natural vegetative cover in the Marseilles Moraine is of little significance. Most of the area is under cultivation and natural vegetation has been removed.

## Engineering Significance of Agricultural Soils Data

A study of the profiles and related data given in the Soil Survey Report indicates that the soil series occurring in the Marseilles Moraine may be grouped, for engineering purposes, as follows:

### Group I

Ade (Aa,b)
Ayr (Ae,d)
Chalmers (Ca,b,c)
Clarence (Cd,e)
Clyde (Cf)
Coloma (Cg,h)
Corwin (Cl,m)
Deardruff (Dd)
Odell (Oa,b)
Parr (Pa,b,c,d,e,f, g,h,k)
Swygert (Se,f)

### Group II

Stockwell (Sa,b)
Tippecanoe (Ta)

## Group III

Edwards (Ea, b, c) Houghton (He)

The above groups of soil series make up the various materials which are shown on the engineering soils map attached as a part of this report. Due to scale limitations and one color reproduction, it was not possible to differentiate on the engineering soils map between some slight variations in soil characteristics in Group I. However, reference to the agricultural soils map and the accompanying report will readily distinguish between these soils. The typical profiles shown in Appendix A indicate the variations in these soils.

The soil series appearing in Group I are glacial till materials. They occur very extensively in the moraine and are the predominant soils. The following paragraphs discuss the various soil series making up this group.

The Ayr and Deardruff series occur on slopes and knolls and are closely associated with the Parr soils. The topsoil is sandy and relatively high in organic material. The sand content decreases, and the clay content increases, with depth. In the Ayr series, the depth of this sandy material extends to about 24 inches, but in the Deardruff it extends to about 54 inches. The parent material for both these soils is a heavy clay till. Internal drainage characteristics, above this clay material, are good. However, the underlying clay is relatively impervious.

The Corwin and Parr also occur in high topographic positions. Slopes range from 2 to 12 percent. The parent

material in the Parr and Corwin contains much less clay. It is composed of unassorted sand, silt, and clay with some gravel particles and rock fragments. The topsoils in these materials are silty and rather high in organic content. This overlies a subsoil in which the clay content increases with depth until it reaches a maximum just above the parent material, at a depth of about 3 feet. These soils drain moderately well internally, due primarily to their high position.

The Swygert and Clarence soils are very similar to those above. However, these soils occupy an intermediate position between the higher soils such as the Parr and depressional soils such as the Clyde or Chalmers. Generally, they occur in relatively level areas. The parent material is a clay till similar to that of the Ayr and Deardruff series. This material, coupled with the topographic position, creates a poor drainage situation both internally and externally. The topsoil in these areas is silty and high in organic content. The subsoil grades from a silt to a silty clay. The clay till parent material occurs at about 25 inches.

The Chalmers, Clyde, and Odell series are the very poorly drained depressional soils. The parent materials from which these soils develop is an unassorted till composed of sand, silt, and clay with some fine gravel and rock fragments. The depth of the altered profile varies from about 2½ feet, in the Odell series, to about 4½ feet in the Chalmers. All of these soils are very high in organic content near the surface and the topsoil is unusually deep, from 12 to 15 inches

as a rule. The subsoil varies from 18 to 40 inches in thickness and is a silty clay material. In the Odell soils the clay content is much higher and it grades to a clay just above the parent material.

The Ade and Coloma series are deep sand deposits developed over unassorted glacial drift. The depth of the sandy material is generally about 6 feet. The topsoil, about 8 inches in depth, varies in organic content and is somewhat silty. The subsoil, to a depth of about 2 feet, is a sandy silt with the percentage of sand increasing with depth. From 2 feet to about 6 feet, the soil is a loose, fine sand. In some instances, these soils occur as low ridges and stable dunes. Internal drainage is excellent above the underlying till.

The soils of Group II are water deposited and are granular in nature. They occur in small deposits, generally, and are quite different from the soils of Group I. The series making up this group are discussed below.

The Stockwell soil occurs in a high topographic position in some instances. Usually it is found in gently sloping situations. The Stockwell overlies a gravel deposit and is one of the two known sources of usable gravel in Newton County. The topsoil is about 7 inches deep and gravel particles are found both on the surface and in the topsoil. The subsoil is a sandy clay containing a considerable number of gravel particles. Immediately above the underlying gravels, a 6 inch layer of gravelly clay occurs. The underlying gravel occurs at a depth of from 40 to 60 inches. It contains a high per-

centage of sand and fine grained material and is fairly well graded. The thickness of the gravel strata is about 12 to 18 inches and it overlies a seam of sand in most instances. It appears to occur from a local outwash situation. It is stratified, certainly suggesting water deposition. Since it occurs in widely scattered deposits, small in extent, and in a till moraine without evidence of being in an outwash channel, it was probably deposited locally and worked into a valley or depression by the melting ice of the glacier.

The other, and more extensive, source of gravel in this area occurs under the Tippecanoe soil. This is a water deposited material which extends into the moraine, filling an old channel. This material is found northeast of the town of Morocco and a gravel pit has been opened in it. The depth to the gravel varies from 4 to 8 feet. A thin seam of clay, about 6 inches thick, overlies the granular material directly. Above this is a strata of sandy and gravelly clay, averaging about 3 feet in thickness. Just beneath the organic topsoil is a strata of silty material containing pebbles and rock fragments. This soil is moderately well drained in the upper part, but the clay strata restricts drainage in the lower part. The gravel pit located northest of Morocco is a commercial operation. Gravel and coarse sand is being removed by dredging. This is a slow process and the output of the pit is small.

The soils of Group III are the Edwards and Houghton series. These are the mucks, peats, and marls and are similar to those

discussed in connection with the Kankakee Basin.

## Correlation of Airphoto Patterns with Agricultural Soils Data

The relationship of the airphoto pattern and the agricultural soils map is illustrated in Figure 6. The airphoto characteristics of this area were discussed previously in this section. The transparent overlay containing the agricultural soil borders emphasizes the correlation between the map and the airphoto pattern. Minute variations in tone and topography reflect different agricultural soils. Inferences as to engineering soils made from the airphoto pattern are reflected by the agricultural soils map.

The Parr, Corwin, Ayr, and Deardruff soils are illustrated in Figure 6. These soils have a medium light tone and occur in the higher topographic positions. The Swygert and Clarence soils are found in areas slightly lower than the Parr. These two soils cannot be identified on the airphotos. The Chalmers, Clyde, and Odell soils generally occupy the lowest topographic positions, and can be identified from this and their dark tones. They are also associated with surface drainage features such as gullies since they are poorly drained soils. The Ade and Coloma, rather deep deposits of sand, appear light in tone on the airphotos and are normally found on knolls or ridges.

The Stockwell series does not appear in Figure 6. However, it usually has a medium to light tone and may be somewhat mottled. It is found in gently sloping areas and old gravel pits may identified in some of the deposits. Figure 7 is a

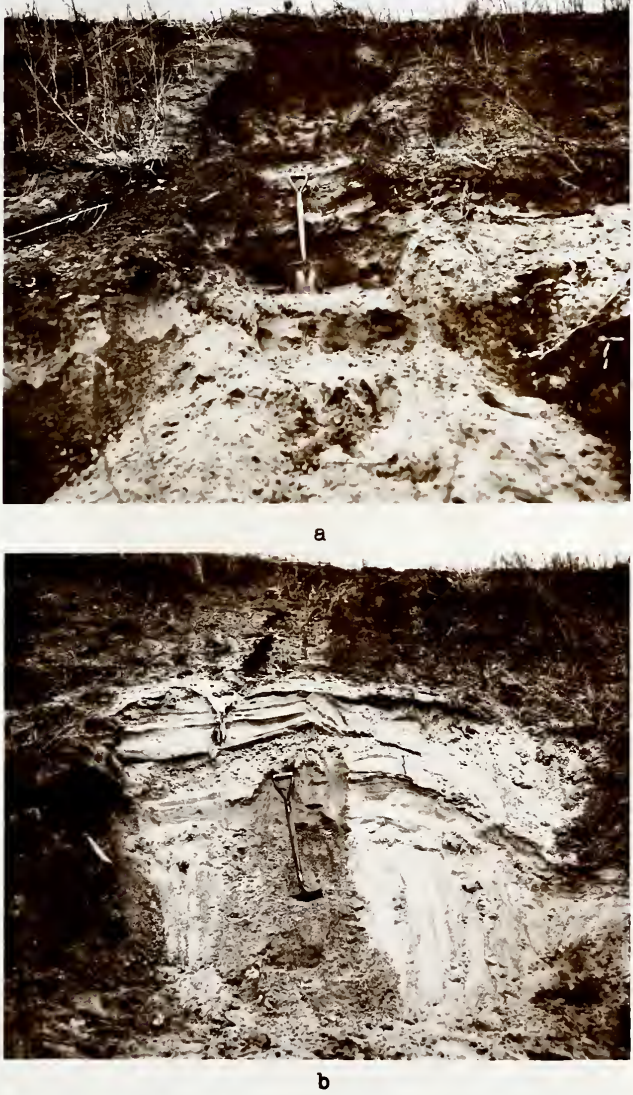


Figure 7. Gravelly Profile in the Marseilles Moraine

ground photo taken in one of these old gravel pits. The upper photograph shows the thick overburden and the lower shows a close up of the gravel strata.

The Tippecanoe soil is water deposited and occurs in old outwash channels. These channels can be identified on the airphotos. Figure 6 illustrates the largest deposit of this material in the Marseilles Moraine. The tone exhibits a mottled effect and the topography is almost level. The agricultural profile indicates that the gravel strata is overlain by sandy to silty clay. Field investigation showed that this is incorrect in most instances. A deep deposit of peat is most generally found above the gravel strata.

The Houghton and Edwards soils, muck, peat, and marl, do not occur in the area covered by Figure 6. However, they appear as dark depressions, undrained in some cases, and can be identified on the airphotos.

## Iroquois Section

### Airphoto Analysis

This area lies between the Tipton Till Plain and the Marseilles Moraine. The topography is level to gently rolling and the major relief features are found adjacent to the Iroquois River and its tributaries.

The drainage pattern is a coarse textured dendritic type. It is composed of both natural and man-made drainage ways. The principal tributary streams of the Iroquois River drain both the Till Plain, on the south, and the moraine, on the

north. The texture of the drainage pattern is less dense in the Iroquois Section than in either of the adjacent sections. This pattern indicates that a considerable amount of drainage is internal.

Erosional features have not developed on a wide scale. The principal drainage ways have been controlled by ditching operations. Natural erosional features are, in general, limited to minor gullies draining into these streams. These gullies have a long, easy gradient and are broad and shallow. This is evidence of a fine grained soil occurring along these streams.

Photo tones in the Iroquois Section vary from a light, almost white tone to a very dark gray. The areas of dark tone are less extensive and are found mostly in the eastern part of the county. Bands of light tone outline artificial drainage ditches. This is the result well drained spoil banks. No one tonal pattern is typical of this section. Tones vary throughout the entire area, but are indicative of the moisture and vegetative situation.

Vegetation is not significant in this section. Except along the river and its principal tributaries, most of the natural vegetation has been removed in order that the land might be cultivated.

The airphoto pattern of this area shows considerable variation, indicating different materials or different origins for similar materials. Field investigation has disclosed that the material underlying this area is glacial drift. This drift

appears at the surface in many places as "islands" surrounded by water deposited material of varying thickness. Wind action has altered the surface pattern of the drift and the water deposited materials. This accounts for the rather wide variations in airphoto patterns throughout this limited area.

Figure 8 is a stereotriplicate illustrating the effects of wind action where both the drift material and lacustrine soils appear at the surface. These three surface patterns stand out individually in this area. The low dune formation is the most prominent. This is identified by the letter "A". "B" indicates small, low dunes or sand deposits spotted at irregular intervals. Area "A" is rather extensive. It swings almost directly west and extends across the county as a low, broken ridge. This is probably the remnant of an old beach ridge, formed by the recession of the water responsible for the lacustrine deposits in this area. This ridge has been reworked by wind action, particularly on the eastern end. Drift material appears on the surface within the area "C". The slightly higher topographic position and the tonal characteristics are the principal features which identify this material. The area marked "D" is composed of water deposited materials on the surface. Field investigation or agricultural soils data is necessary to differentiate between the water deposited soils and the glacial materials. It cannot be done from the airphotos alone.

Figure 9 is a stereotriplicate of an area about 6 miles to the west of that covered by Figure 8. The pattern here

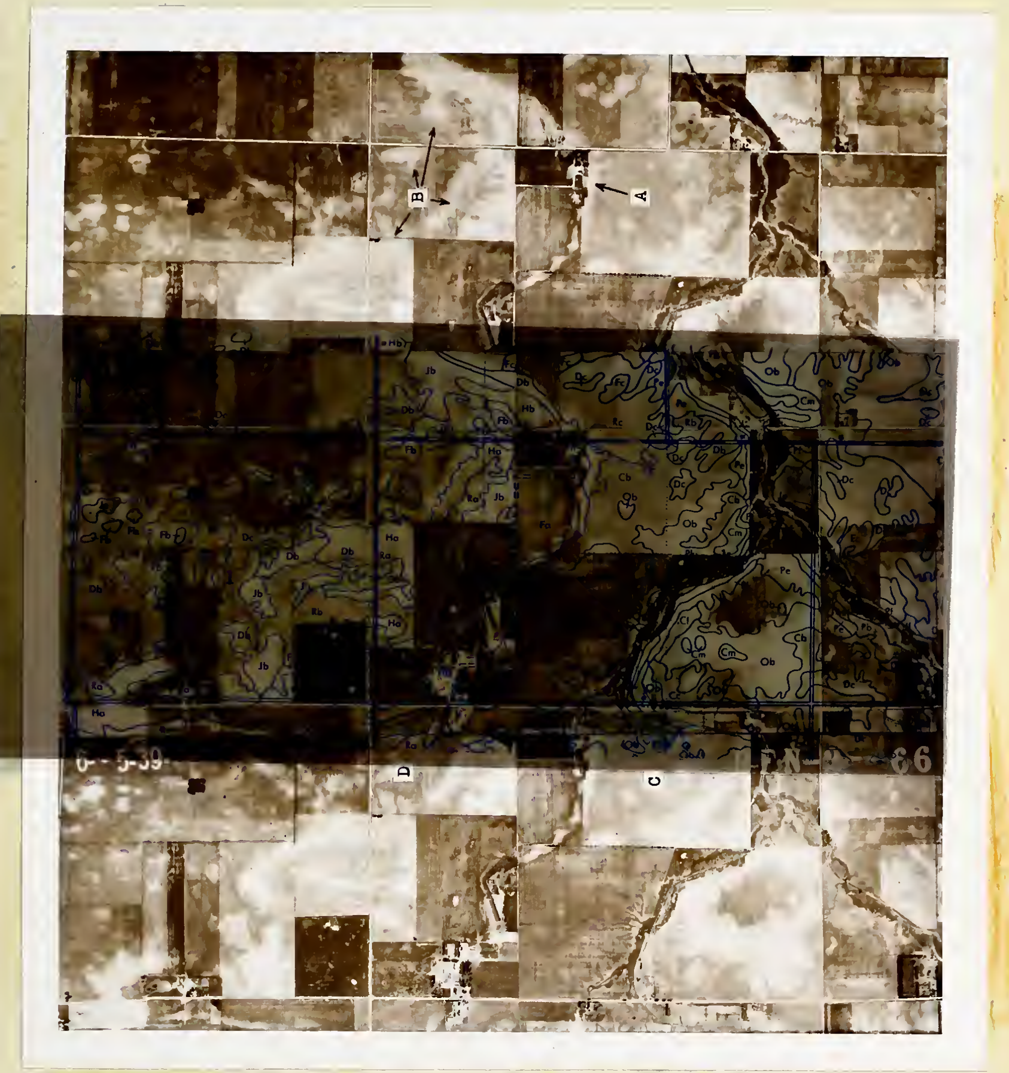
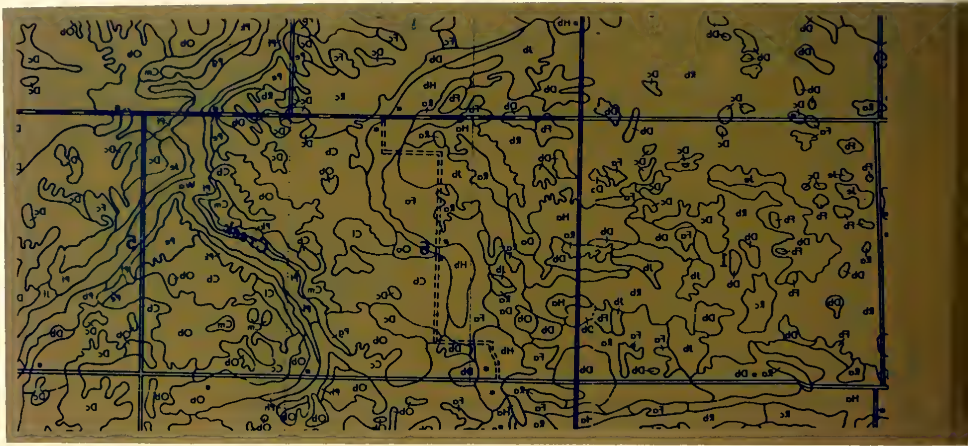


Figure 8. Soil Patterns of the Iroquois Section. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



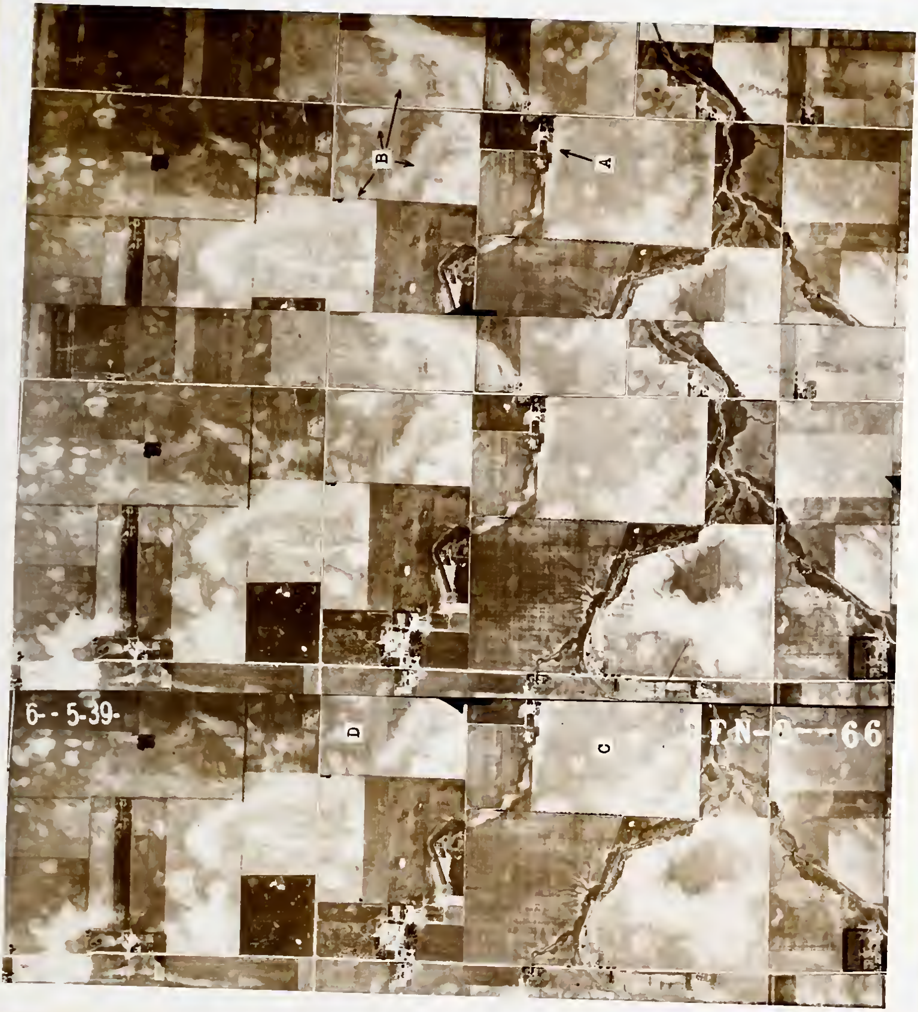


Figure 8. Soil Patterns of the Iroquois Section. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

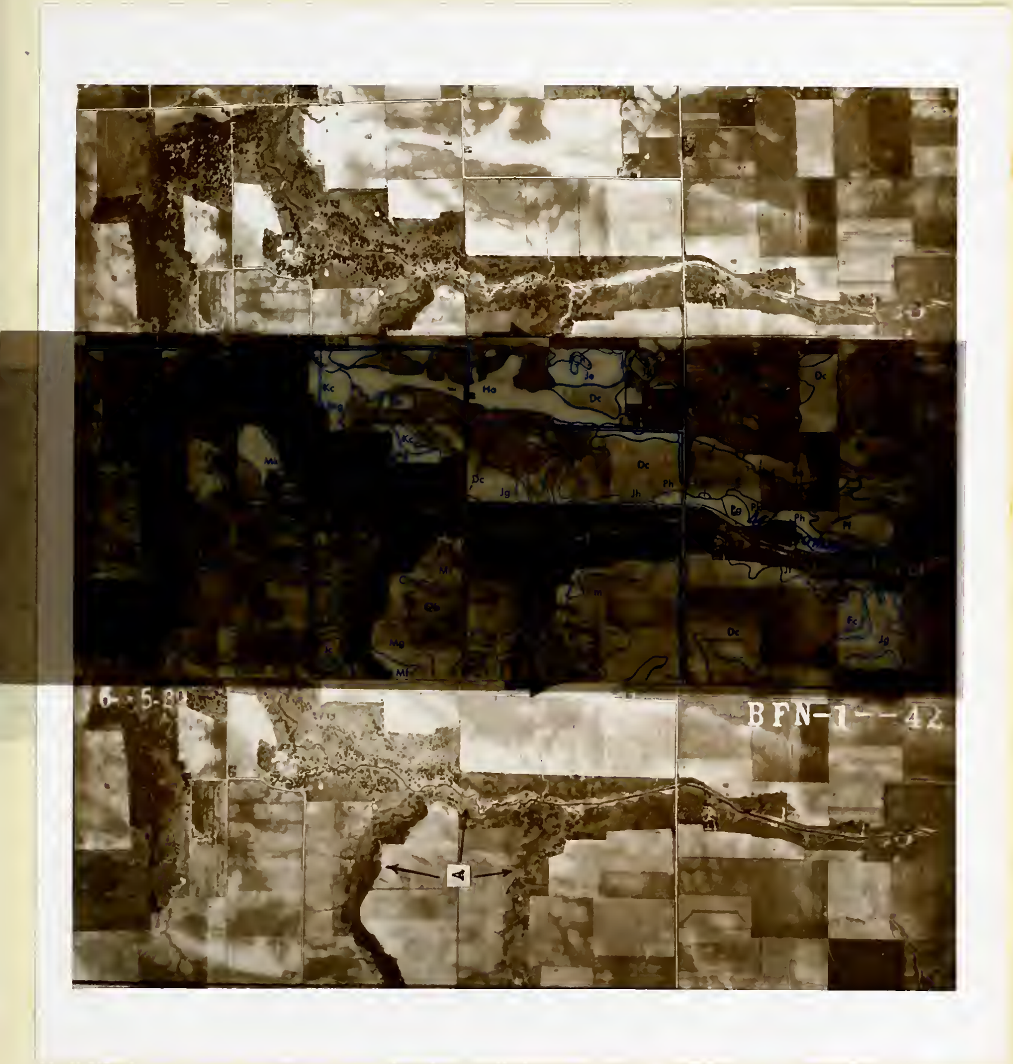
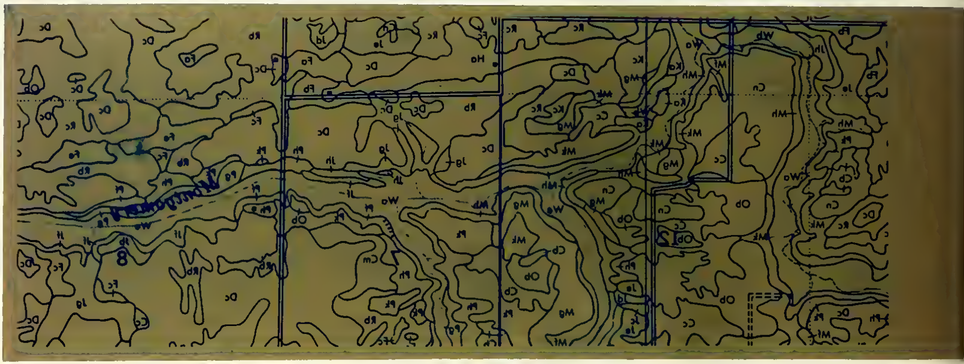


Figure 9. Soil Patterns of the Iroquois Section. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



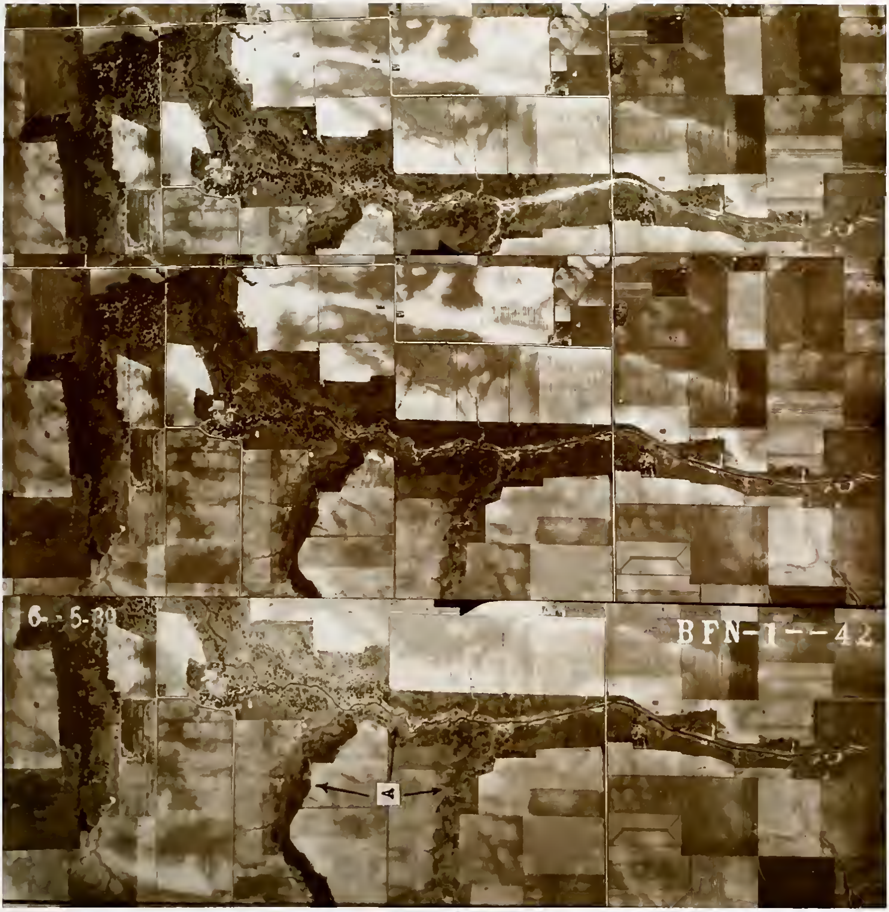


Figure 9. Soil Patterns of the Iroquois Section. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

is somewhat different, though the materials are essentially the same. An additional material, a stream deposited floodplain soil, occurs here. This material, identified by the letter "A", was deposited along the floodplains of the small streams. These streams have been straightened in some places by ditching operations in an effort to improve drainage and stop unnecessary erosion. The photo tones in these areas are a medium gray for the most part, but are spotted with lighter and darker areas. The lighter areas are indicative of leaching of the spoil banks in sections where ditching operations occurred, and the darker areas are evidence of undrained depressions and small slack water areas where water has ponded. These slack water areas are higher in organic content than the surrounding areas. Gullies crossing this floodplain are broad and shallow except where they cut down sharply from the upland. Soils in these areas are silts and clays, transported by water from adjacent areas, and are rather poorly drained.

The main, or east-west, stream in this illustration serves as a dividing line between two different surface materials. Differences in tone and gully development differentiate between these areas. On one side of the stream the gullies back in the upland are narrower and have steeper gradients, and the depressional areas are darker in tone. In addition, a subdued mottled effect is suggested. This is evidence of a drift material. Field investigation confirmed this. On the other side of the stream, gully shape and gradient and

tonal characteristics are different. The gullies are broad and shallow and have a very gentle gradient. They are dark in tone and contrast sharply with the adjacent higher areas. The low, light toned ridge, extending in an east-west direction through this area, is the western extremity of the ridge discussed in Figure 8. These areas are indicative of fine sands overlying the lacustrine deposits. Wind action has probably reworked them considerably. The materials in this area are predominantly lacustrine silts and clays.

Figure 10 is a stereotriplicate of an area just north of the Iroquois River and west of U.S. 41. The airphoto pattern of this area indicates a surface material different from the ones previously discussed and illustrated. The most significant features of this pattern are the tonal variations and the drainage situation. These are closely interrelated since the drainage situation is responsible for the tonal characteristics.

Gully development has been retarded by the internal drainage characteristics of this material. Locally, drainage is mostly internal. Very little precipitation is carried off by surface runoff A number of low depressional areas, identified in Figure 10 by the letter "A", act as small collecting basins for surface runoff. These basins drain internally. Other evidence of internal drainage are the tonal variations characterized by the mottled effect indicated by "B" in Figure 10. The narrow dark toned areas collect runoff from the immediately adjacent higher and lighter toned areas. Organic matter also

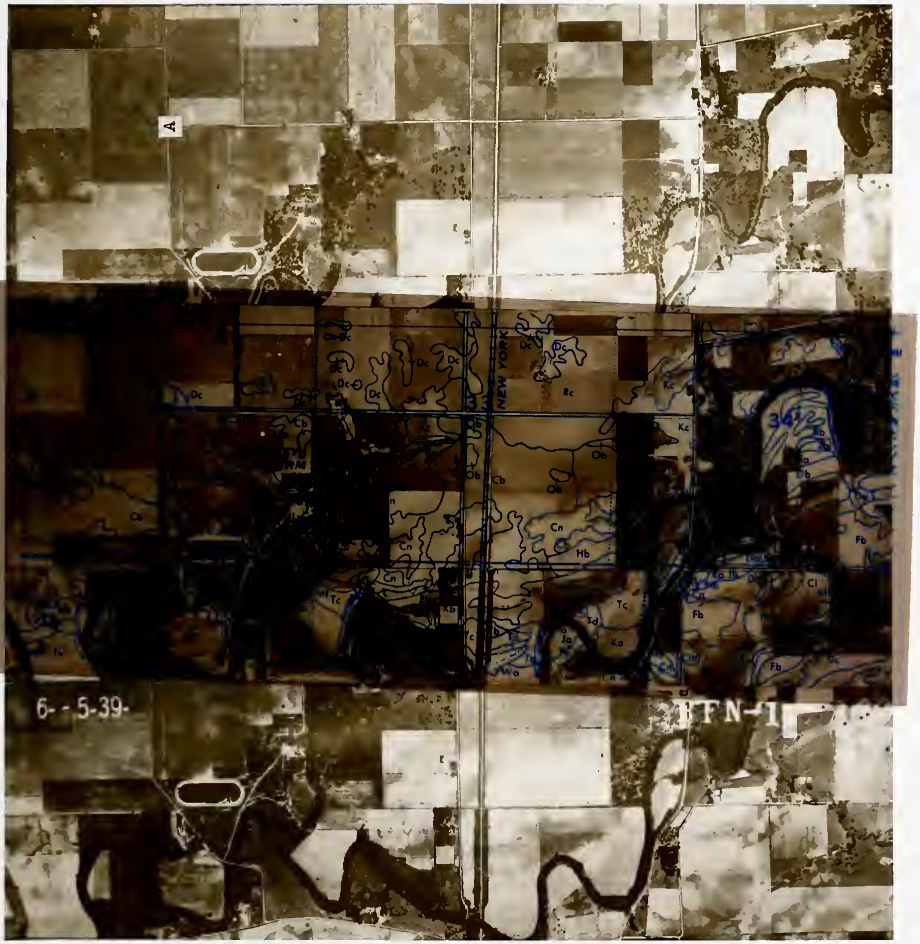


Figure 10. Soil Patterns of the Iroquois Section.
This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

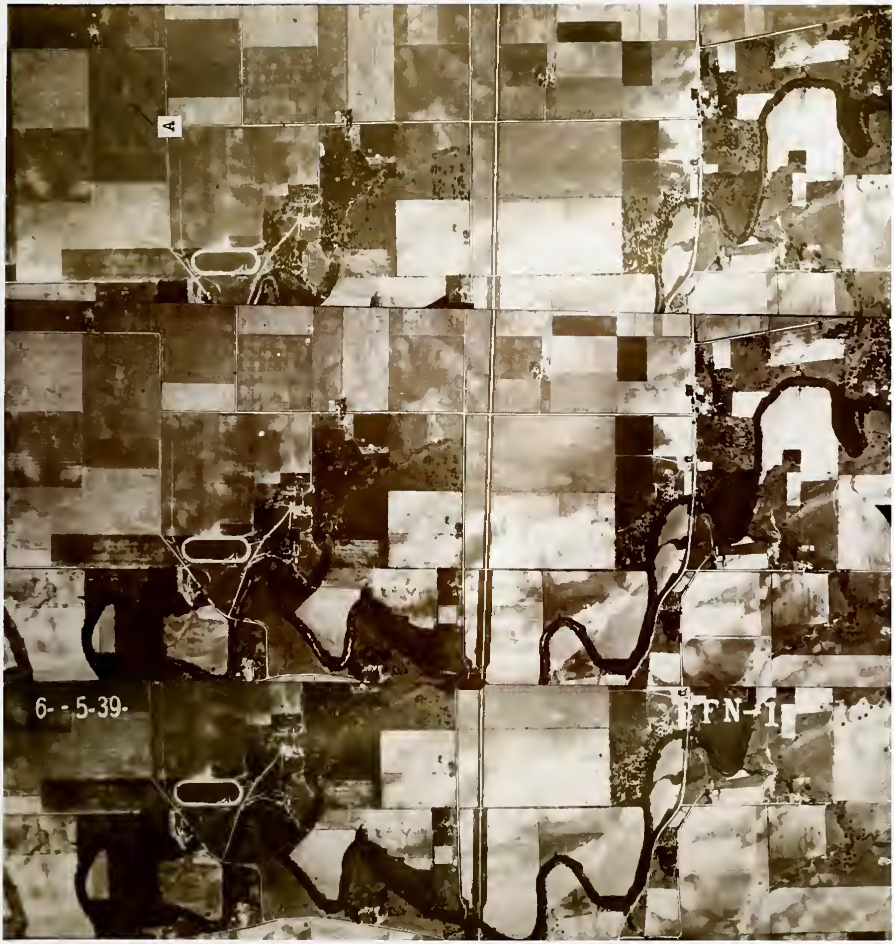


Figure 10. Soil Patterns of the Iroquois Section. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

collects in these small depressions. Indications are that the material here is somewhat granular in nature, fine sands with some silt and possibly a small amount of clay.

The Iroquois River is the principal drainage feature of this section. Its tributaries drain a fairly large area in Newton County. The river has a very irregular channel with many sharp, angular twists and turns where it has not been altered by artificial means. In a number of places current scars result from the scouring action of flooding; however, the artificial "ox-bow" lakes, found only in the eastern half of the county, appear to result from ditching operations and not from the meandering of a stream in early maturity. The twists and turns of this river appear to exhibit a certain amount of parallelism. Figure 10 shows this effect. It appears that these are indications of the influence of joints in the underlying limestone bedrock. About five miles to the south, this bedrock outcrops in a quarry. The banks of this river are very high and steep in many places. This indicates that the channel has previously occupied a higher position, and has cut its way downward. Field investigation has revealed that drift material is exposed frequently on the outside of the bends. This is another indication that the stream is lowering, or has lowered, its channel. Generally, the soils occupying the insides of the bends are alluvial silts and clays while those on the outside of the bends are either glacial drift or lacustrine deposits similar to those found further back from the river.

Another notable feature in this discussion of the Iroquois River is the parallelism reflected by its main tributaries as shown in Figure 9. These exhibit roughly the same orientation as the bends of the main river. One notable exception to this stands out. This tributary flows parallel to the direction of the river for a considerable distance before turning north and emptying into the Iroquois. Again, it is felt that the underlying bedrock controls the direction of these streams. At the Kentland quarry, field investigation revealed that this bedrock was tilted practically on end. It is quite possible that the parallelism exhibited by both the bends in the main stream and the channels of the tributaries result from control by the bedding planes in this tilted bedrock.

From the foregoing discussion of the airphoto pattern of the Iroquois Section, indications of five principal materials are found. These are fine grained lacustrine deposits, glacial drift, lacustrine sands and silts, fine grained alluvial deposits, and wind worked sands.

The fine grained lacustrine soils are silts and clays, for the most part, but some fine sands will be found also. Internal drainage is rather poor and the natural surface drainage has been aided by ditching operations.

The glacial drift material found on the surface in this section is similar to that of the Till Plains to the south. This soil appears as "islands" in this lacustrine plain. From this, it can be assumed that the lacustrine deposits of this section overlie glacial drift materials.

The more granular lacustrine deposits, those composed primarily of fine sands and silts, were evidently deposited under conditions where the flow was sufficient to carry off the finer particles. These soils are fairly well drained internally.

The deposits of alluvial silts and clays occur in the floodplains of the Iroquois River and its principal tributaries. These are high in organic content and are very poorly drained. The sand deposits include both dune sands and old beach ridges which have been reworked by wind action. These are well drained materials and occupy topographic positions which are somewhat higher than the surrounding areas.

### Engineering Significance of Agricultural Soils Data

The following groups of soil series are those which form the basis for the different materials on the engineering soils map. Due to scale limitations and one color reproduction, it was not always possible to show textural symbols and minor variations in texture. The soils in Groups I and II reflect this situation. However, reference to the agricultural soils map will readily differentiate between the various textural classifications of these soils.

Group I

Darroch (Da,b,c)
Foresman (Fa,b,c)
Jasper (Ja,b,c,d,
e,f,g,h)
Kibbie (Kb,c)
Rennselaer (Ra,b,c)
Tuscola (Tb,c,d)

Group II

Kaskaskia (Ka)
Wabash (Wa,b)

### Group III

Hagener (Ha,b,c)

### Group IV

Julian (Jk)

Strole (Sc,d)

### Group V

Chalmers (Ca,b,c)
Corwin (Cl,m)
Crosby (Cn)

Miami (Mf,g,h,k)
Odell (Oa,b)
Parr (Pa,b,c,d,e,
f,g,h,k)

The soils of Group V are Wisconsin drift materials and are similar to those found in the Till Plain to the south and in the Marseilles Moraine to the north. These soils are discussed in connection with those sections and will be omitted here. These glacial materials appear to be either high areas which were not covered by the lacustrine deposits in this area, or areas where the overlying water deposits have been eroded away, exposing the underlying glacial material at the surface.

The soils of Group I are stratified lacustrine materials composed primarily of layers of sand and silt with some layers of clay. The soil series making up this group are discussed individually below in order to emphasize the variations within this group.

The Darroch and Rennselaer series are developed from essentially the same parent material. The only difference between these soils is in topographic position and drainage characteristics. The Darroch is better drained than the Rennselaer and occurs in a higher topographic position. Both of these soils have a parent material composed of stratified

layers of sands and silts with some clay and some fine gravel. The thickness and sequence of layers varies considerably from place to place. This parent material begins at a depth of from 30 to 36 inches, usually. The topsoil is about 6 to 8 inches in thickness and overlies about 24 to 30 inches of a highly variable material composed of sand, silt, and clay. In most cases, this subsoil material is rather plastic.

The Foresman, Jasper, and Kibbie differ from the Darroch and Rennselaer in that they have more clay strata in the parent material. The Foresman and Kibbie soils have poorer drainage characteristics than does the Jasper. The Jasper occurs in a higher topographic position. This accounts for its better drainage characteristics. The profiles of the Foresman, Jasper, and Kibbie are quite similar to those of the Darroch and Rennselaer except for the exceptions mentioned above.

The profile of the Tuscola soil is similar to that of the Darroch and Rennselaer in that the parent material is composed of stratified sand and silt with some layers of clay and fine gravel. However, it is generally located near the Iroquois River and its tributaries on slopes varying from 2 to 20 percent.

The soils of Group II, the Kaskaskia and the Wabash, are floodplain soils and occur along the Iroquois River and its tributaries. The parent material is an alluvial material which has been washed from the surrounding areas. These soils are subject to flooding at least once a year, in most cases.

The Wabash contains a greater amount of clay than does the Kaskaskia and flood waters remain on this soil longer. Internal drainage in the Wabash is poor. The topsoil is a silty clay, high in organic content, and about 12 inches deep. The subsoil is also a silty clay material and extends to a considerable depth. The Kaskaskia has a more silty profile which results in better drainage characteristics. It is also found in higher topographic position than the Wabash.

The Hagener series, Group III, is quite different from either of the groups discussed above. It is a deep deposit of fine sand. The principal difference between the topsoil and the subsoil is the organic content which is high in the topsoil. Below a depth of 20 inches, this material is a clean fine sand. The well drained condition of this soil has retarded profile development to such an extent that no system of horizons has developed.

Group IV, the Julian and Strole series, has a lacustrine clay parent material. The Julian series is characterized by poor drainage conditions and it is ponded for part of each year where no artificial drainage has been provided. The topsoil is a silty clay high in organic content and about 7 inches deep. The subsoil is similar to the topsoil in texture, but grades into the parent material at a depth of about 35 inches. Thin seams or lenses of fine sand are found imbedded in this clay parent material. In some places the Julian series has a strata of muck at a depth of about 4½ feet. When this occurs it overlies a deep deposit of marl. This condition is

not shown on the agricultural soils map and it can only be determined by augering.

For engineering purposes, the Strole series is quite similar to the Julian. It is very poorly drained and is found in low, flat areas. The topsoil is about 7 inches deep and is high in organic content. The subsoil is a silt grading into a silty clay and then, at a depth of about 30 inches, into the clay parent material.

### Correlation of Airphoto Patterns with Agricultural Soils Data

The agricultural soil series, types, and phases in this section readily lend themselves to grouping and correlation with the airphoto pattern. Changes in topographic position, tone, and minute drainage features reflect different types and phases of a series, if not a different series. Reference to the agricultural soils data gives more detailed infromation than can be portrayed on the engineering soils map.

Figure 9 is a stereotriplicate of a pattern showing the relationship of Foresman, Jasper, Rennselaer, Darroch, Strole, and Julian soils among others. A considerable number of the various types and phases of the series occur in this area, but they are unimportant for engineering purposes.

The Jasper soils occupy the highest topographic positions and exhibit a light tone. The Foresman soils are closely associated with the Jasper but occupy a slightly lower position and reflect a generally darker tone. The Darroch soils occupy an intermediate position between the Foresman and the low

lying Rennselaer soils, and in most cases cannot be distinguished from the Rennselaer on the airphotos. Both the Darroch and the Rennselaer appear dark in tone and occupy low areas.

The airphoto pattern in areas of the Julian and Strole series is dark in tone. Generally, artificial drainage is found in these areas also. These soils occupy low topographic positions and occur extensively in the eastern part of the Iroquois Section, the area covered by Figure 9.

Figure 10 best illustrates the airphoto pattern of the Kaskaskia and Wabash soils. These are floodplain soils along the Iroquois River. They vary in tone from light to dark, reflecting moisture and vegetative conditions. Generally speaking, the Kaskaskia soils are found in the low areas on the inside of bends in the river. Usually, the Wabash is found back from the river, adjacent to the upland face in slack water areas. These two series are difficult to distinguish between on the airphotos. However, the agricultural map locates them precisely.

The Tuscola and Kibbie series appear to be quite similar on the airphoto. However, the Tuscola has a greater range in slopes and is usually found on the upland face. It appears light in tone. The Kibbie is darker in tone than the Tuscola and is found in more level areas.

The Hagener series is easily identified on the airphotos. It is light in tone and is found in the form of low ridges or dunes. It stands out prominently when viewed in stereo.

## Tipton Till Plain

### Airphoto Analysis

This area covers the extreme southern part of the county. The airphoto pattern is rather subdued when compared to the typical pattern that occurs in other sections of Indiana. This is due to the shallow depth of the drift material, and to the fact that to the north the drift has been reworked and overlain by water deposited material.

The land form is that of a gently rolling to level plain. The flatness of this area is emphasized on the airphotos by the rectangular highway system and the absence of cuts and fills of appreciable dimensions. The "basin-knoll" relationship, typical of Wisconsin till plains, has been modified to some extent. The dark depressions are interconnected for the most part, and appear as low, winding, dark bands. These are broad and shallow. The knolls are represented by slightly higher areas of light tone intermingled with the dark bands.

Surface drainage features are better developed than that usually associated with Wisconsin till and a denser dendritic pattern is found. Many of the natural drainage ways have been straightened somewhat by excavation, and both natural and man-made characteristics are exhibited in a number of the drainage ways. These drainage ways have additional significance in that a number of them show indications of being controlled by some underlying material. The thickness of the drift near the limestone quarry east of Kentland varies from a minimum

of about 2 feet to a maximum of about 20 feet as disclosed by field investigation. This indicates that the streams showing control are influenced by the underlying limestone bedrock.

The typical Wisconsin till pattern is also modified by surface features. Extending across in an east-west direction from the southeastern corner of the county is a ridge. The absence of erosional features and its light tone indicate a well drained material such as sand. This was confirmed by field investigation which also disclosed evidences of water deposition and some evidence of reworking by wind. This ridge is a remnant of an old beach ridge formed by the waters responsible for the deposits in the Iroquois Section to the north. Figure 11 is a stereotriplicate showing this feature. The beach ridge is identified by the letter "A" in the illustration. "B" is the limestone quarry, and "C" is a controlled stream east of the quarry. The letter "D" indicates the point where a secondary road crosses the ridge mentioned previously. The subdued "basin-knoll" relationship can be seen in this illustration also. Area "E" is an elongated, dark toned depressional area resulting from interconnection of the basin areas. This has formed a shallow, broad gully which drains into the nearby stream.

The airphoto pattern indicates that the materials in this section are predominantly fine grained. This is evidenced by the density of the drainage pattern and the tonal variations exemplified by the dark, wide, and shallow depressional areas surrounding higher areas of lighter tone. These depressions

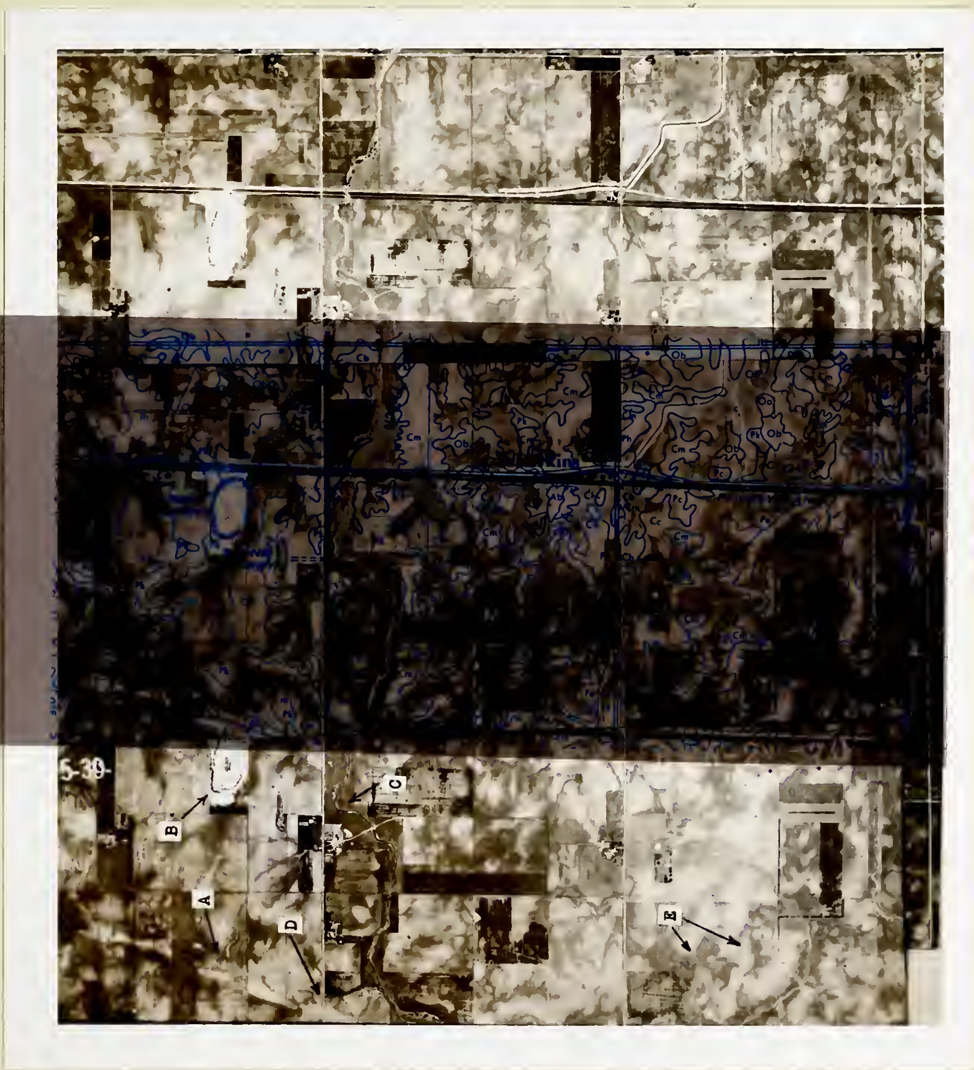
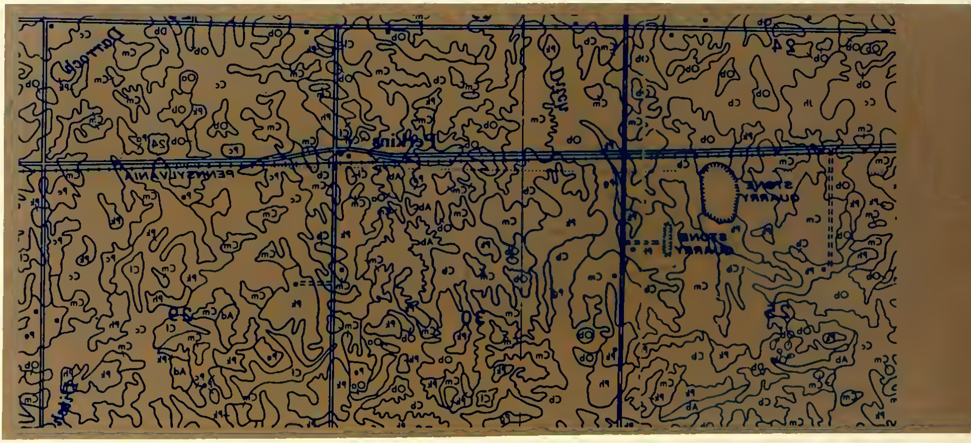


Figure 11. Soil Patterns of the Tipton Till Plain. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.



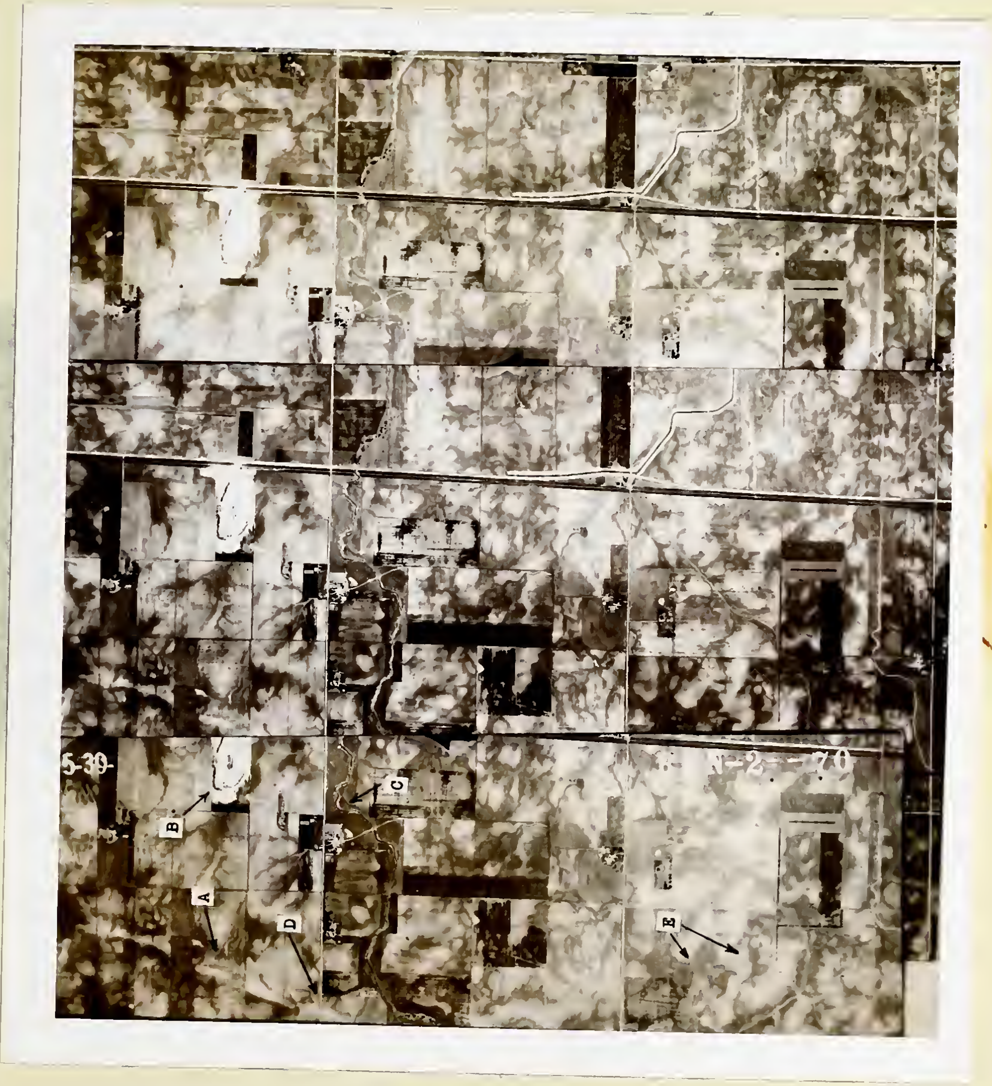


Figure 11. Soil Patterns of the Tipton Till Plain. This stereotriplicate illustrates soil patterns and their relationship to various agricultural soil series. See Chapter IV for discussion.

will contain a higher percentage of organic matter and will be more moist than the higher areas which they surround.

This till material is composed of unassorted sands, silts, and clays with some gravel particles. The bedrock outcrops at the Kentland quarry and in a stream bed near Goodland. This indicates that the drift is relatively shallow.

Alluvial soils occur along the stream bed northeast of Goodland. These soils are dark toned and show evidence of water working, and are predominantly silts and clays.

## Engineering Significance of Agricultural Soils Data

From a study of the data contained in the Agricultural Soil Survey Report (5), the following soils were grouped:

Group I

Ayr (Ae,d)
Chalmers (Ca,b,c)
Clarence (Cd,e)
Clyde (Cf)
Corwin (Cl,m)
Crosby (Cn)

Deardruff (Dd)
Miami (Mf,g,h,k)
Odell (Oa,b)
Parr (Pa,b,c,d,e.
f,g,h,k)
Swygert (Se,f)

Group II

Ade (Aa,b)

Group III

Wabash (Wa,b)

Group IV

Stockwell (Sa,b)

Group I, the most common soils, are the series developed from a glacial till material of Wisconsin age. These cover most of the area. The parent material of these soils is an unassorted glacial drift. From an engineering standpoint,

differences in these soils are of a minor nature. Textures vary in the topsoil and subsoil to include various combinations of sands, silts, and clays, and slopes vary from 0 to about 16 percent. The depressional soils such as the Clyde, and the soils found in level areas or on the more gentle slopes, are higher in organic content and usually have a higher clay content in the subsoil. Internal drainage is slow in most of these soils though some, such as the Parr and others found on the steeper slopes or with a higner sand content, are moderately well drained internally. Most drainage, however, is through surface runoff. These soils have been considered in the discussion of the Marseilles Moraine and it is not necessary that this discussion be repeated here.

Due to scale limitations and one color reproduction, the textural variations in the soils of Group I could not be shown on the engineering soils map. Reference to the agricultural soils map will, however, give detailed variations in these soils. In most cases, these variations will not be significant to the engineer.

The Ade series, Group II, is a deep deposit of sand over till. It occurs in high topographic positions and has been reworked by wind in most cases. Texturally, it is a fine sand and it possesses excellent drainage characteristics. Usually, this soil occurs in deposits a minimum of 7 to 8 feet in depth.

The Wabash, Group III, is an alluvial soil found along

the stream bed northeast of Goodland. The Stockwell, Group IV, is a gravelly soil which is found along S.R. 55 about one mile south of its intersection with U.S. 24. These two materials, the Wabash and Stockwell, are definitely in a minority and are not significant when considering the area as a whole. Both have been previously discussed in connection with the Iroquois Section and the Marseilles Moraine, respectively.

### Correlation of Airphoto Patterns with Agricultural Soils Data

Comparison of the stereotriplicate shown in Figure 11 with the overlay of the same area, readily shows the relationship of the various soil series occurring there. Differences are mainly in topographic position, drainage situation, and organic content. The parent material of these soils are mapped on the engineering soils map as similar drift materials, unassorted sand, silt, and clay with some gravel particles. This area is typical of the soils of the Tipton Till Plain section. The soils situated in a higher topographic position, and light in tone, are the Parr and Corwin series. Those darker in tone and occurring in lower areas are the Chalmers, Clyde, and Odell.

The airphoto pattern of the Till Plain soils has been discussed in connection with other sections in this chapter. Airphoto pattern features discussed there will hold true for soils occuring in the Till Plains.

# CHAPTER V

# CONCLUSIONS AND RECOMMENDATIONS

The methods of preparing engineering soils maps which were explored in this study indicate a degree of accuracy sufficient for the purposes for which the maps are intended. All other things being equal, the accuracy of detailed soil characteristics and properties is dependent upon the extent of field sampling and laboratory testing accomplished during the mapping process. This problem becomes one largely of a balance between manpower, economics, and the intended uses of the final map and accompanying data.

The information contained on the engineering soils maps may be divided into the following categories; texture of the surface soils and underlying materials, and surface and subsurface drainage conditions. From this information, general considerations as to the suitability of the soils for foundations and use as construction materials can be determined. The accuracy regarding each of these, utilizing the methods set forth in this study, are considered below.

Both airphotos and agricultural soils maps readily adapt themselves to broad engineering textural and drainage determinations. The amount of field investigation and testing in this regard is only that required to correlate agricultural soil profiles and the airphoto pattern. The resultant information is sufficiently accurate to be suitable for location of granular construction materials and for predicting soil

engineering problems involving textural and drainage considerations.

Surface and sub-surface drainage is closely related to texture and a study of one necessitates investigation of the other. The drainage characteristics of soils in their natural condition is investigated at length in the preparation of agricultural soils maps. These data are sufficiently accurate for engineering purposes. However, the drainage characteristics may change considerably upon remolding during the construction procedures. Consideration of the drainage characteristics in a remolded condition would necessitate very extensive field sampling and laboratory testing. The economic aspects prohibit this.

The accuracy of the determination of the general suitability of the soils for use as foundations and as construction materials is dependent to a great extent upon the evaluation and interpretation of both the airphoto pattern and the agricultural soils data. In addition, engineering judgment must be utilized to balance economic considerations and field investigation. As previously stated, the soils map is not intended to be a substitute for subsurface foundation exploration, but should indicate where field exploration and laboratory testing should be concentrated.

The application of airphotos to the identification of agricultural soil series proved to have definite limitations. Variations between soil series, in most instances, are not readily apparent from the airphotos. Soil series with dis-

tinctive characteristics, such as the Plainfield dune sands and the Tippecanoe gravel deposits, can be identified. However, soils such as the Odell, Chalmers, and Clarence, which occur in association with each other, have variables not apparent from the airphotos alone. By using the agricultural soils map in conjunction with the airphotos, the minute variations between soil series becomes apparent. By grouping the soil series on the basis of engineering characteristics, soil borders can be drawn on the airphoto with a higher degree of accuracy than from airphotos alone. In this study, however, the reverse of this procedure was used. The airphoto pattern was used as the basis for grouping agricultural soil series and the engineering soil borders were drawn on the agricultural soils map. This procedure proved to be accurate and faster.

The overall economics of this type study are very favorable and indicate that herein lies the most economical approach to the completion of the Engineering Soils Mapping Program in Indiana. The cost of this study was about $1000, of which approximately half was the salary of the compiler. The procedure outlined in this study is economical in time, manpower, and money. Laboratory test data gathered in this study may be correlated with agricultural soil series in other locations and cut down on the amount of field sampling and laboratory testing necessary in mapping other areas.

It is strongly recommended that the Joint Highway Research Project consider this type study for future work on the Engineering Soils Mapping Program.

## BIBLIOGRAPHY

1. McLerran, James H., "State of Washington Engineering Soils Manual, Part I - The Engineer and Pedology," Division of Industrial Research, State College of Washington, Washington State Council for Highway Research, 1954.

2. "Soils and Men," Yearbook of Agriculture, Part IV, Fundamentals of Soil Science, United States Department of Agriculture, United States Government Printing Office, 1938.

3. "Soil Survey of Newton County, Indiana," United States Department of Agriculture, Soil Conversation Service, in cooperation with Purdue University Agricultural Experiment Station, Series 1941, No. 14, March, 1955.

4. Lobeck, A.K., "Physiographic Diagram of North America," The Geographical Press, Columbia University, New York, 1950.

5. "Handbook of Indiana Geology," Department of Conservation, Indianapolis, Indiana, 1922.

6. Logan, W.N., "The Sub-Surface Strata of Indiana," Publication No. 108, Department of Conservation, Indianapolis, Indiana, 1931.

7. Leverett, Frank, "The Illinois Glacial Lobe," United States Government Printing Office, 1899.

8. Johnstone, J.G., Mintzer, O.W., Parvis, Merle, Montano, P., Miles, R.D., Shepard, J.R., and Frost, R.E., "A Manual on the Airphoto Interpretation of Soils and Rocks for Engineering Purposes," School of Civil Engineering and Engineering Mechanics, Purdue University, March, 1953.

9. Belcher, D.J., Gregg, L.E., and Woods, K.B., "The Formation, Distribution, and Engineering Characteristics of Soils," Joint Highway Research Project, Engineering Experiment Station, Purdue University, January, 1943.

# APPENDIX A

## SOILS OF NEWTON COUNTY

### Engineering Characteristics

The agricultural soils considered in this appendix are those which do not appear in Bulletin 87, "The Formation, Distribution, and Engineering Characteristics of Soils," published by the Joint Highway Research Project in 1943. The soil series appearing in Newton County and which are considered for engineering purposes in Bulletin 87 (9) are listed below.

Berrien
Bridgman
Clyde
Coloma
Corwin
Crosby
Dillon
Griffin
Maumee
Maimi
Newton
Odell
Parr
Plainfield

This appendix deals with the engineering characteristics of the agricultural soil series found in Newton County and not covered in Bulletin 87. These are 28 in number and are listed below for reference purposes.

Ade
Alida
Ayr
Chalmers
Clarence
Conrad
Darroch
Deardruff
Della
Edwards
Foresman
Granby
Hagener
Houghton
Jasper
Julian
Kaskaskia
Kibbie
Morocco
Rennselaer
Stockwell
Strole
Swygert
Tippecanoe
Tuscola
Wabash
Weiss
Wooten

These soils can be broken into groups on the basis of formation and parent materials. The soil series listed below are grouped on this basis. Each soil series in these groups is considered from the standpoint of its engineering characteristics in the discussion which follows the grouping.

### Group A - Muck and Peat

Edwards
Houghton

### Group B - River Floodplains

Kaskaskia
Wabash

### Group C - Wisconsin Drift

Ade
Ayr
Chalmers
Clarence
Deardruff
Stockwell

### Group D - Lake and Outwash Plains

Alida
Conrad
Darroch
Della
Foresman
Granby
Hagener
Jasper
Julian
Kibbie
Morocco
Rennselaer
Strole
Swygert
Tippecanoe
Tuscola
Weiss
Wooten

Table I shows test data compiled for this study. Atterberg Limits were run on selected samples from a number of agricultural soil series. Due to the stratified nature of many of these soils, limit data was difficult to correlate.

### Group A - Muck and Peat

Edwards. This series occurs throughout the county, generally in rather small deposits. The profile of this soil is illustrated in Figure A-1. It is essentially a deep deposit of marl overlain by 18 to 24 inches of muck. It is

# Table I

## Atterberg Limits Data

(From tests conducted for this study)

| Soil Name | Depth (inches) | Liquid Limit | Plastic Limit |
|---|---|---|---|
| Ayr | 15 | 49 | 25 |
| | 60 | 17 | 12 |
| Chalmers | 34 | 48 | 21 |
| | 52 | 20 | 13 |
| Clarence | 30 | 46 | 23 |
| | 78 | 29 | 19 |
| Darroch | 13 | 26 | 14 |
| | 22 | 58 | 22 |
| Deardruff | 40 | 24 | 15 |
| | 66 | 20 | 14 |
| | 76 | 20 | 14 |
| Della | 28 | 72 | 28 |
| | 44 | 53 | 30 |
| Foresman | 28 | 42 | 19 |
| | 50 | 23 | 19 |
| | 62 | 24 | 20 |
| | 72 | 31 | 18 |
| Jasper | 38 | 46 | 18 |
| | 30 | 25 | 14 |
| Julian | 30 | 44 | 22 |
| | 50 | 30 | 21 |
| | 68 | 21 | 20 |
| Kaskaskia | 24 | 46 | 23 |
| | 48 | 24 | 13 |
| Kibbie | 14 | 22 | 16 |
| | 26 | 29 | 15 |
| | 36 | 26 | 14 |
| | 62 | 34 | 17 |
| Rennselaer | 22 | 46 | 21 |
| | 30 | 43 | 19 |
| | 54 | 44 | 21 |

Table I (con't.)

| Soil Name | Depth (inches) | Liquid Limit | Plastic Limit |
|---|---|---|---|
| Stockwell | 19 | 24 | 14 |
| | 28 | 25 | 15 |
| Strole | 33 | 82 | 36 |
| | 40 | 51 | 27 |
| | 50 | 16 | 12 |
| | 60 | 13 | 11 |
| Swygert | 20 | 60 | 28 |
| | 34 | 29 | 21 |
| Tuscola | 16 | 23 | 16 |
| | 34 | 22 | 16 |
| | 60 | 31 | 21 |
| Wabash | 36 | 62 | 37 |

found in low, undrained depressional areas. From an engineering standpoint, it is extremely undesirable and should be avoided if at all possible. Three types of Edwards soil appear on the agricultural soils map. Edward muck (Ea) is the most extensive and is typical of the series. A burned phase (Ec) is found in some places. This differs from the Edwards muck in that the overlying muck deposit has been burned. Edwards loamy muck (Eb) is a transitional soil, found mainly in the Kankakee Basin, and is intermediate between the Edwards and the Maumee.

Houghton. This soil occurs in two basically different types. Houghton muck (He) is a deep deposit of muck and peat and is extremely undesirable as an engineering material. Three other phases (Hd,f,g) are shallow deposits of muck over sand. These materials appear on the engineering soils map as organic sands. The overlying muck layer varies in thickness from 14 to 36 inches and could be excavated if construction was necessary in these areas. The underlying sand is well drained and would furnish a good foundation material. Figure A-1 illustrates a profile typical of this series.

## Group B - Floodplain Soils

Kaskaskia. This soil is found along the Iroquois River and its tributaries in Newton County. It is forned from alluvium washed from the surrounding upland soils. It is silty and fairly well drained internally. It usually occupies a slightly higher topographic position than the associated Wabash series and flood waters do not stand on it for long

periods of time. Highway construction in areas of Kaskaskia soil would necessitate fills and bridges, chiefly because of the problem of flooding. The airphoto pattern indicates that bedrock is found at a relatively shallow depth along the Iroquois River and would furnish a solid foundation for bridge supports. A typical profile appears in Figure A-1.

Wabash. This soil is muck more plastic than the Kaskaskia and is poorly drained. It is usually found in the lower areas along the Iroquois River and its tributaries. The soil is predominantly a silty clay. Engineering considerations are essentially the same as those for the Kaskaskia with the added problems of poorer drainage and lower supporting power. A typical profile of this soil appears in Figure A-2.

### Group C - Wisconsin Drift

Ade. This material is a deep sand deposit resulting from wind erosion of a sandy till. It occurs as low dunes and ridges and is found most extensively in the Marseilles Moraine. Internal drainage is excellent and it possesses good characteristics for foundation material. This profile is illustrated in Figure A-2.

Ayr. This soil is characterized by a relatively shallow deposit of sandy material over a light clay till material. It occurs in areas of slight relief and possesses moderate internal drainage characteristics. Drainage in the clay till parent material is more restricted than in the upper portion of the profile. At about 30 inches the sandy nature of the

soil grades into a silty clay. In construction, where cuts extend below the sand, typical silty clay problems are encountered. Figure A-2 contains a profile typical of this soil.

Chalmers. This material is developed from a glacial till composed of unassorted sand, silt, clay, and rock fragments. It is found in nearly level to depressional areas. Surface runoff is low and internal drainage is poor. Figure A-3 contains an illustration of the profile of this soil. Engineering problems include drainage, frost action, and pumping. The "B" horizon of this soil has more definite clay properties and is a plane of weakness in cuts.

Clarence. This is a very poorly drained material. The parent material is a fairly plastic clay till. The topsoil is very high in organic matter and overlies a "B" horizon of silty clay. The unaltered till material is found at a depth of about 2 feet. Problems of construction are concerned mainly with drainage and supporting power for subgrades. A typical profile is shown in Figure A-3.

Deardruff. This soil is quite similar to the Chalmers. The primary difference in the two soils is in the "B" horizon. The Deardruff contains a sandy material overlying the glacial till parent material. Drainage is much better due to the sandy nature of this material. The parent material appears to be a fairly good foundation material. Figure A-3 contains a profile typical of this soil.

Stockwell. This soil is developed on a gravelly parent material, apparently water deposited, in upland areas. It is

moderately well drained internally and surface runoff is low. The 6 to 8 inches of topsoil is high in organic content and overlies a sandy clay subsoil. A strata of "dirty gravel" is found at a depth of about 4 feet. Pits have been opened in this gravelly strata in a number of places, but none are worked at the present time. It is fairly well graded and would compact to relatively high unit weights, forming a good foundation material. However, the gravel strata is quite variable in thickness and the quantity of material available is not too great. Figure A-4 illustrate a profile typical of this soil.

Swygert. From the profile in Figure A-4 it is apparent that this is a predominantly clay material. It is poorly drained and presents problems typical of fine grained, plastic soils. These include low supporting power, drainage, pumping, and frost action.

### Group D - Lake and Outwash Plains

Alida. This soil is found in the Kankakee Basin in level to nearly level topographic situations. It is predominantly a quartz sand and is well drained internally where the prevailing high water table has been lowered by artificial drainage. This soil furnishes excellent subgrade materials and engineering problems other than drainage are insignificant. Figure A-4 contains a profile of this soil.

Conrad. This material is a sand similar to the Alida. Few areas of Conrad soil have been artificially drained and

most are under water, or nearly so, due to the extremely high water table. Where the water table can be lowered, this soil offers no significant engineering problems and furnishes a good subgrade material. A typical profile is illustrated in Figure A-5.

Darroch. This is a lacustrine soil overlying a parent material of stratified sand and silt with some lenses of clay and fine gravel. The topsoil, varying in depth from 6 to about 12 inches, is high in organic content and overlies a sandy and silty clay subsoil. The parent material is encountered at about 3 feet. This soil possesses poor internal drainage characteristics due to the nature of the "B" horizon. The parent material furnishes good foundation material. However, if the "B" horizon is used in subgrades, trouble can be expected. Figure A-5 contain a profile of this soil.

Della. This is a very poorly drained soil, both internally and externally. Under natural drainage conditions most of these areas are ponded for much of the year. The "B" horizon is a highly plastic silty clay material with poor supporting power. The parent material is a stratified silt, sand, and clay, with the clay predominanting. The soil is poor for engineering purposes in general. It is very susceptible to frost action and pumping.

Foresman. This soil is a lacustrine material developed from a parent material of stratified layers of sand and silt with some lenses of clay and fine gravel. The topsoil is high in organic content and overlies a sandy clay. This

material contains enough sand and silt to give it moderate internal drainage characteristics. The clay content increases with depth and is concentrated just above the parent material. Drainage in this strata is very poor and the soil is very plastic when wet. The parent material is a good material, however, for use in subgrades and embankments. Figure A-6 contains a profile typical of this soil.

Granby. This is a deep sand deposit similar to the Alida and Conrad. It occurs in the Kankakee Basin in association with the Maumee and Newton soils. The natural water table is very high and where no artificial drainage has been provided the soil is essentially ponded for much of the year. One phase of the Granby has a mucky subsoil. This strata is about 10 inches in thickness and occurs at a depth of about 12 inches. The remaining phases of the Granby offer no engineering problems where the water table can be lowered. It is good material for subgrades and foundations. A typical profile of this soil appears in Figure A-6.

Hagener. This is also a deep sand. The engineering characteristics of this soil indicate that it is an excellent construction material. It is well drained internally and presents no significant engineering problems. A profile appears in Figure A-6.

Jasper. This soil occurs in small deposits principally in the Iroquois Section. It is developed from a stratified parent material containing layers of sand and silt with some lenses of clay and fine gravel. It occurs in a high topographic

position and is fairly well drained. The parent material offers good material for subgrades and foundations, but the "B" horizon contains a considerable amount of clay and is much less desirable. A typical profile is illustrated in Figure A-7.

Julian. This is a complex material, highly variable, but with clay predominanting throughout the profile. It is extremely poorly drained even where artificial drainage has been provided for agricultural purposes. It is sometimes found overlying a deposit of marl. The subsoil and the parent material is a highly plastic clay containing lenses of sand and presents many problems when used for engineering purposes. It is susceptible to frost action and pumping and would have a very low supporting power. Figure A-7 contains a profile typical of this soil.

Kibbie. This soil occurs in nearly level areas and is very poorly drained. The topsoil is low in organic content and overlies a sandy clay material. This subsoil grades into a silty clay above the parent material and restricts drainage. The parent material is stratified sand and silt with some clay and fine gravel and is a good foundation material. Engineering problems concern drainage and supporting power above the "C" horizon. Figure A-7 illustrates a typical profile.

Morocco. This soil occurs in the Kankakee Basin. It is a deep sand deposit which is an excellent construction material. The water table is high, however, and presents a problem. The material is well drained internally where the water table has

been lowered. Figure A-8 contains a typical profile.

Rennselaer. This is a poorly drained material occurring in low topographic positions. The subsoil is plastic when wet and presents problems concerning drainage and low supporting power. The "C" horizon is a much better engineering material and furnishes good supporting power when used in subgrades and embankments. A typical profile is illustrated in Figure A-8.

Strole. This is a clay material with very poor drainage characteristics. For engineering uses, it is a poor material. It presents problems concerned with low supporting power, pumping, and frost action. The high clay content is apparent from the profile in Figure A-8.

Tippecanoe. This material is found in old channels. At depths of from 4 to 8 feet or deeper, a strata of gravel and coarse sand is found. The gravelly strata is overlain by peat in most instances, but may be overain by a gravelly sand and silt. The gravel material is very good borrow and is a source of a limited amount of aggregate. The profile of this soil is illustrated in Figure A-9.

Tuscola. This is a moderately well drained soil which occurs in high topographic positions near the Iroquois River. The topsoil is low in organic content and about 6 inches in depth. It overlies a silty clay subsoil. The stratified parent material is encountered at about 3 feet and is predominantly silt and sand, but it contains some layers of clay and fine gravel. Figure A-9 contain a profile of this

soil.

Weiss. This is a well drained, deep sand deposit. In most areas where this soil is found the water table has been lowered for agricultural purposes and no engineering problems of any consequence are encountered. It is a good construction material. A typical profile appears in Figure A-9.

Wooten. This is also a deep sand deposit. However, it differs from the Weiss in that a layer of mucky and peaty material occurs at a depth of about 3 feet. This strata varies from 6 to 18 inches in thickness. Figure A-10 contains a profile typical of this soil.

## Soil Identification

Table II was extracted from Bulletin 87 (9). It presents a summary of the various materials appearing in the typical profiles. The descriptions of materials which follow discuss the characteristics of the materials summarized in Table II.

> Material No. 1 - Topsoil. This material extends to a depth seldom greater than a few inches and may usually be recognized by its characteristic color, its high organic content, or textural differences. Because it can be identified by visual inspection and its properties are so variable, no test results were used for classifying topsoil.
>
> Material No. 2 - Sand. Most soils contain varying quantities of material ranging in size between the No. 10

and No. 200 sieves, quantities designated as the "sand fraction." When this size of material predominates, the soil is classified as sand by visual inspection. Wide variations in gradations are found, the lake and dune deposits frequently representing the fine one-sized type, with glacial deposits usually being graded from coarse to fine. This material is identical with the Bureau of Public Roads A-3 soil.

Material No. 3 - Gravel and Sand. Reasonably clean gravel and sand has been designated as "Gravel and Sand." No tests are necessary for identification purposes, although a wide range in sieve analyses is indicated.

Material No. 4 - Gravel, Sand, Silt, and Clay. Glacial and river deposits frequently composed of a well graded gravel containing 5 to 20 percent of sand, silt, and clay sizes have been given the above identification. Sieve analyses are required for positive identification. Low liquid limits are indicated for the material passing the No. 40-mesh sieve, the plasticity index generally being below 10 or 12. This is the Bureau of Public Roads A-1 soil and is often ideal for traffic-bound surfaces or in some instances for base courses.

Material No. 5 - Silt - Clay, Sand, and Gravel. This material, frequently referred to as "dirty gravel," contains about equal proportions of material above and below the No. 200-mesh sieve. Morainic and river terrace deposits frequently contain such soil.

Material No. 6 - Silt. This unusual soil is easily recognized by touch because of its silky texture. Being largely a one-sized material and having definite plasticity and cohesion when wet, yet little cohesion when dry, it has a low value of plastic limit as compared to liquid limit. This material is commonly referred to as "rock-flour" silt and falls within the Bureau of Public Roads A-4 soil group.

Material No. 7 - Silt with Sand and/or Gravel. This common type of soil, combined with Material No. 8, predominates as parent material in both the Wisconsin and Illinoian glacial deposits. The granular texture, indicated by both sieve analyses and "feel," contributes to the low liquid limit and plasticity index values. The relatively high laboratory weights (compacted) also indicate generally good performance for use as embankments or subgrades when properly compacted.

Material No. 8 - Silt with Clay and Sand. This is a more plastic material than Material No. 7 with correspondingly higher liquid limit and plasticity index and slightly lower compacted densities.

Material No. 9 - Silt Clay. This unusual soil is similar to Material No. 6, but has a slightly higher clay content with resulting higher Atterberg Limits. The silky texture of the No. 6 is present. The exceptionally low compacted densities indicate a troublesome soil, particularly in construction work when the moisture content

greatly exceeds the plastic limit. This material is prevalent in some horizons of the Illinoian drift area and is typical of the Bureau of Public Roads A-5 soil.

Material No. 10 - Clay with Silt and Sand. This common type of soil generally has a plasticity index of about 50 percent of the liquid limit contrasted to the much lower plasticity index of the No. 9 soil--with corresponding values for liquid limits. When wet, the material has a typical clay-like, sticky touch--when dry, the material is quite hard and contains shrinkage cracks. The material is found as "clay pan" or frequently as the "B" horizon of many of the Wisconsin drift soils, particularly those derived from argillaceous shales.

Material No. 11 - Clay with Silt. The absence of sand is indicated in this soil by both sieve analysis and by the relatively high plasticity index in relation to the liquid limit. The soil has more definite clay properties than the No. 10 soil, with correspondingly lower laboratory compacted weights. In the natural state, definite structure patterns are common. Most residual, lacustrine, and depressional soils contain this material in some horizon.

Material No. 12A - Clay with Silt (Colloidal). A highly cohesive soil with high liquid limits and high plastic limits--usually over 70 percent of the liquid limit. The soil is found occasionally in certain geological strata such as underclays, in limestone residual

areas, and in some level or depression soils of the Wisconsin drift. The clay-like soils are represented by soil Nos. 8, 10, 11, and 12A--No. 8 being the least cohesive and No. 12A being the most cohesive. (Note the occurrence of this soil immediately above bedrock in the Bloomington, Burgin, Corydon, Frederick, Hagerstown, and Orleans soil profiles, as well as in Clyde, Conover, and Harbison.)

Material No. 12B - Clay with Silt (Organic). An unusual soil, similar to soil Nos. 6 and 9 in that the plastic limit is exceptionally low in comparison to the liquid limit. It is not uncommon to find soils with a liquid limit of 100 or over and a corresponding plasticity index less than 25. The material is not widespread, being limited primarily to depression soils. The silts are represented by soil Nos. 6, 9, and 12A. (Note the occurrence of this soil in Brady, Newton, and Walkill.)

Material No. 13 - Rock-Soil Mixture. This material is not common as a native soil, its distribution being more or less limited to residual areas where rock-soil mixtures are common in cuts, or to such geological types as are represented by the shale-limestone deposits of the Ordovician systems. Soil-test constants vary widely.

Material No. 14 - Muck, Peat, or Coal. This legend is used extensively for organic deposits in the Wisconsin drift areas and for the coals of the Pennsylvanian system. These materials are identified readily by inspection.

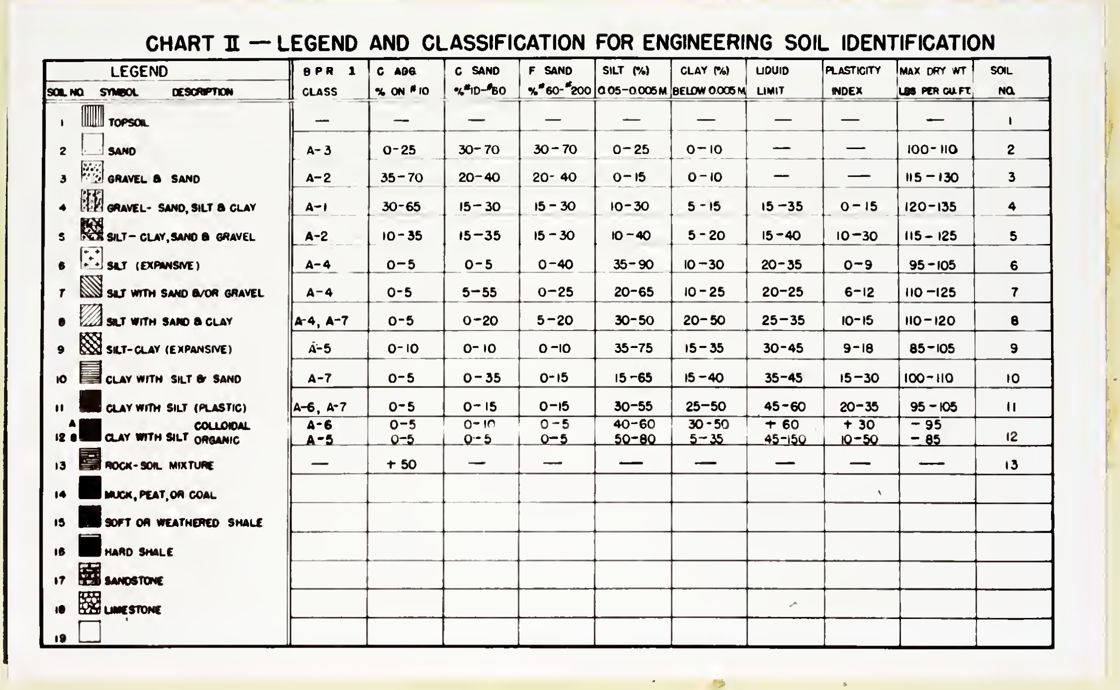
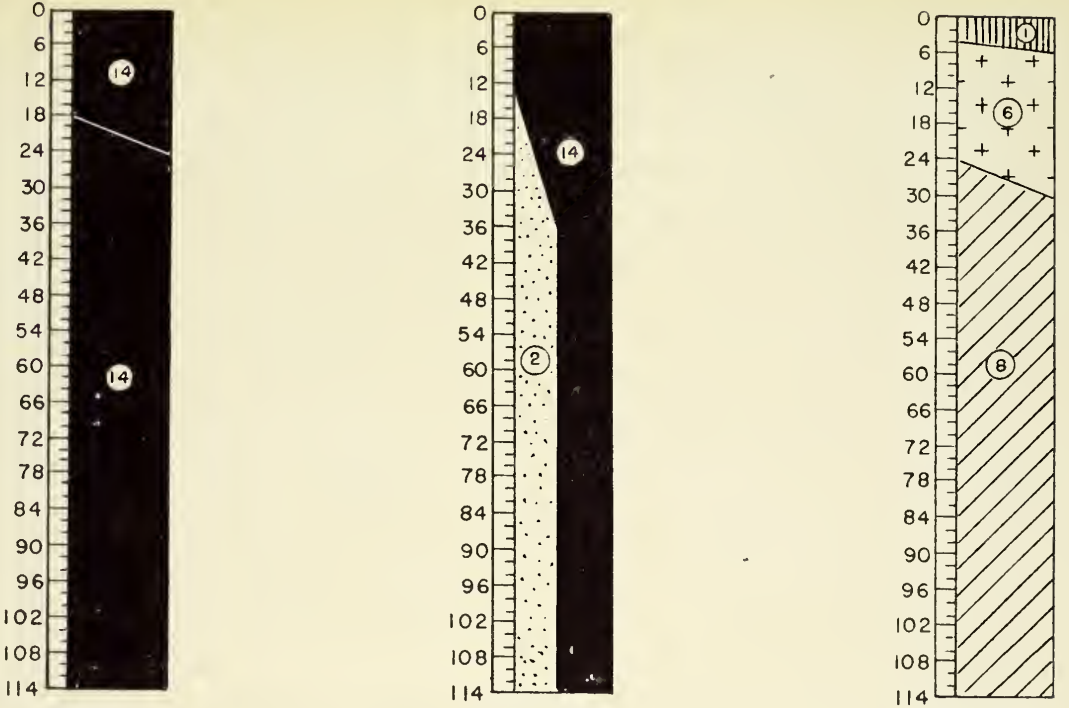


CHART II — LEGEND AND CLASSIFICATION FOR ENGINEERING SOIL IDENTIFICATION

| LEGEND | | | B P R 1 | C AGG | C SAND | F SAND | SILT (%) | CLAY (%) | LIQUID | PLASTICITY | MAX DRY WT | SOIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOIL NO. | SYMBOL | DESCRIPTION | CLASS | % ON #10 | % #10–#60 | % #60–#200 | 0.05–0.005 M | BELOW 0.005 M | LIMIT | INDEX | LBS PER CU. FT. | NO. |
| 1 | ▥ | TOPSOIL | — | — | — | — | — | — | — | — | — | 1 |
| 2 | □ | SAND | A-3 | 0-25 | 30-70 | 30-70 | 0-25 | 0-10 | — | — | 100-110 | 2 |
| 3 | ▒ | GRAVEL & SAND | A-2 | 35-70 | 20-40 | 20-40 | 0-15 | 0-10 | — | — | 115-130 | 3 |
| 4 | ▦ | GRAVEL- SAND, SILT & CLAY | A-1 | 30-65 | 15-30 | 15-30 | 10-30 | 5-15 | 15-35 | 0-15 | 120-135 | 4 |
| 5 | ▩ | SILT- CLAY, SAND & GRAVEL | A-2 | 10-35 | 15-35 | 15-30 | 10-40 | 5-20 | 15-40 | 10-30 | 115-125 | 5 |
| 6 | ⁘ | SILT (EXPANSIVE) | A-4 | 0-5 | 0-5 | 0-40 | 35-90 | 10-30 | 20-35 | 0-9 | 95-105 | 6 |
| 7 | ▧ | SILT WITH SAND &/OR GRAVEL | A-4 | 0-5 | 5-55 | 0-25 | 20-65 | 10-25 | 20-25 | 6-12 | 110-125 | 7 |
| 8 | ▨ | SILT WITH SAND & CLAY | A-4, A-7 | 0-5 | 0-20 | 5-20 | 30-50 | 20-50 | 25-35 | 10-15 | 110-120 | 8 |
| 9 | ▩ | SILT-CLAY (EXPANSIVE) | A-5 | 0-10 | 0-10 | 0-10 | 35-75 | 15-35 | 30-45 | 9-18 | 85-105 | 9 |
| 10 | ▤ | CLAY WITH SILT & SAND | A-7 | 0-5 | 0-35 | 0-15 | 15-65 | 15-40 | 35-45 | 15-30 | 100-110 | 10 |
| 11 | ■ | CLAY WITH SILT (PLASTIC) | A-6, A-7 | 0-5 | 0-15 | 0-15 | 30-55 | 25-50 | 45-60 | 20-35 | 95-105 | 11 |
| 12 A | ■ | CLAY WITH SILT COLLOIDAL | A-6 | 0-5 | 0-10 | 0-5 | 40-60 | 30-50 | + 60 | + 30 | - 95 | 12 |
| B | | ORGANIC | A-5 | 0-5 | 0-5 | 0-5 | 50-80 | 5-35 | 45-150 | 10-50 | - 85 | |
| 13 | ▤ | ROCK-SOIL MIXTURE | — | + 50 | — | — | — | — | — | — | — | 13 |
| 14 | ■ | MUCK, PEAT, OR COAL | | | | | | | | | | |
| 15 | ■ | SOFT OR WEATHERED SHALE | | | | | | | | | | |
| 16 | ■ | HARD SHALE | | | | | | | | | | |
| 17 | ▦ | SANDSTONE | | | | | | | | | | |
| 18 | ▦ | LIMESTONE | | | | | | | | | | |
| 19 | □ | | | | | | | | | | | |

Table II. Legend and classification for engineering soil identification (9).



EDWARDS

0-2 Percent

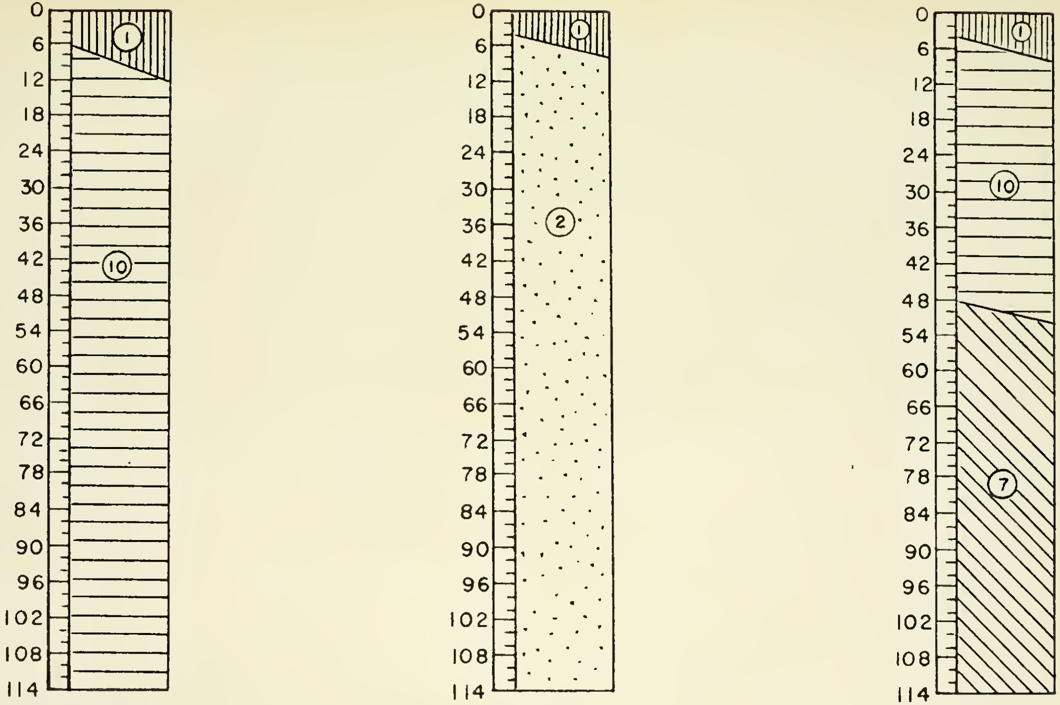
HOUGHTON

0-2 Percent

KASKASKIA

0-2 Percent

Figure A-1. Typical Profiles

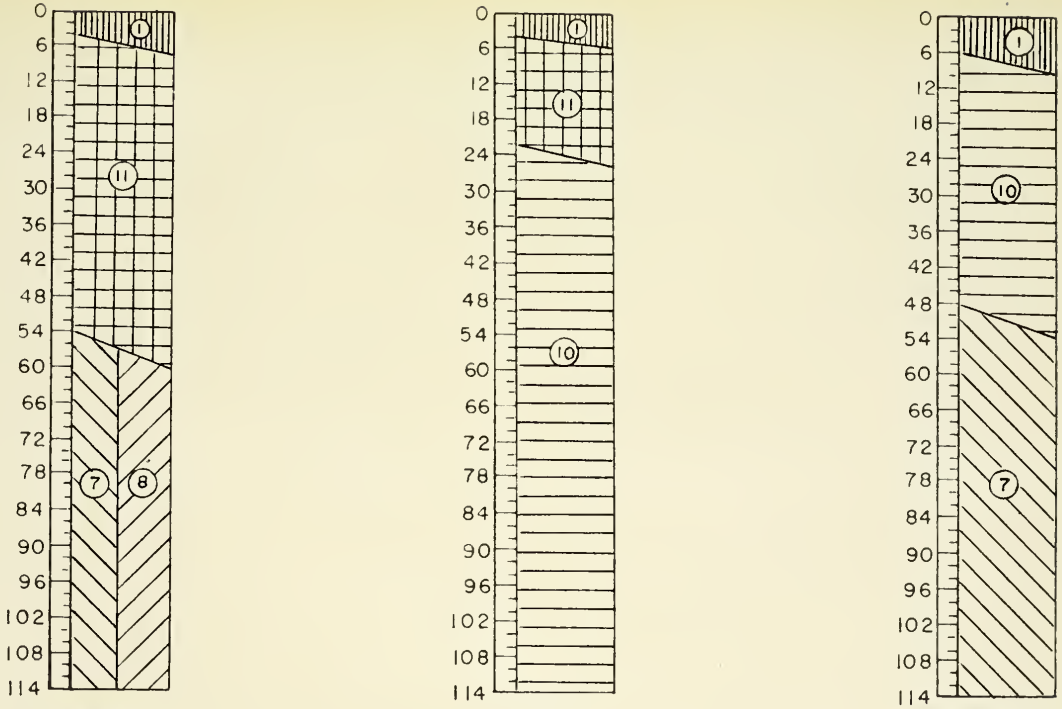


**WABASH**
0-2 Percent

**ADE**
0-5 Percent

**AYR**
2-5 Percent

Figure A-2. Typical Profiles



CHALMERS

0-2 Percent

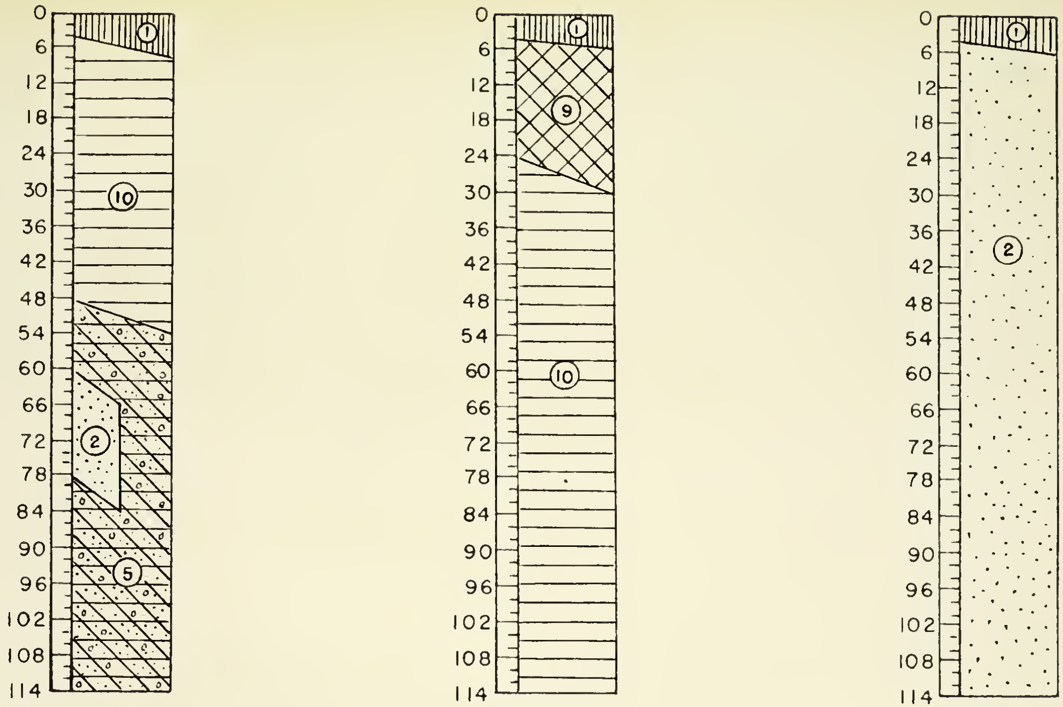
CLARENCE

0-3 Percent

DEARDRUFF

0-2 Percent

Figure A-3. Typical Profiles



STOCKWELL

2-12 Percent

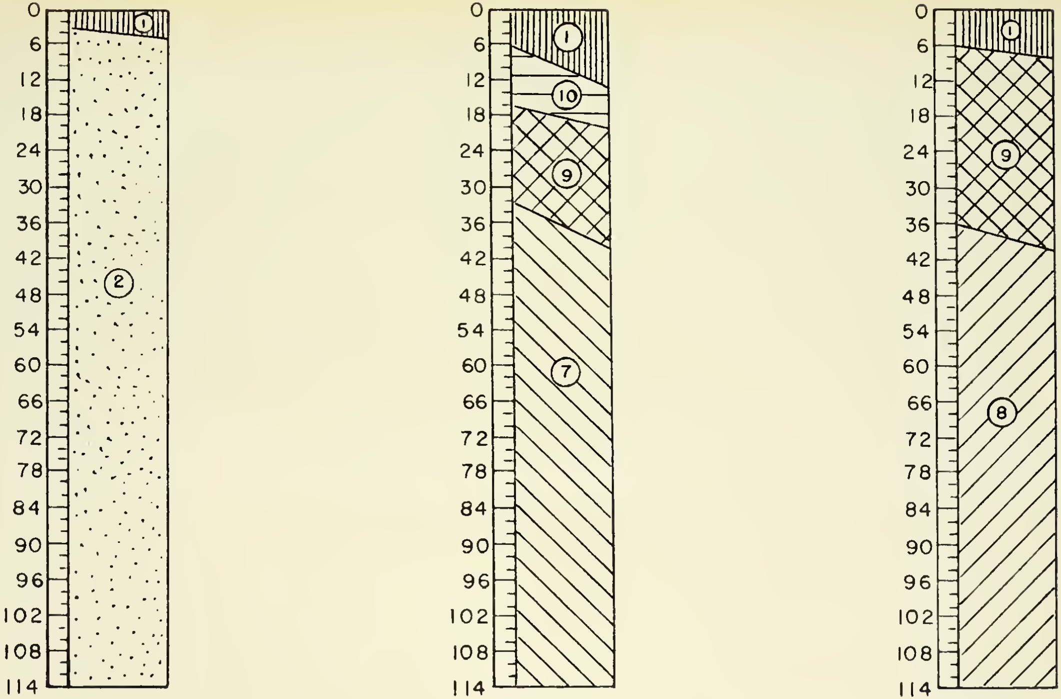
SWYGERT

1-3 Percent

ALIDA

0-2 Percent

Figure A-4. Typical Profiles



CONRAD

0-2 Percent

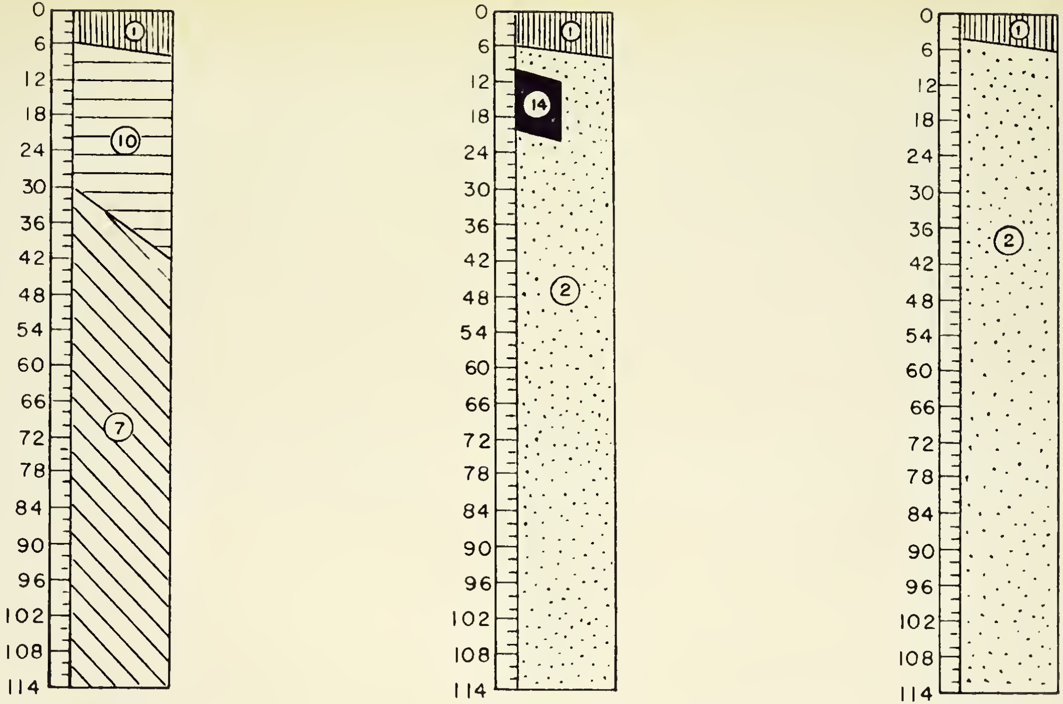
DARROCH

0-2 Percent

DELLA

0-2 Percent

Figure A-5. Typical Profiles



**FORESMAN**

0-2 Percent

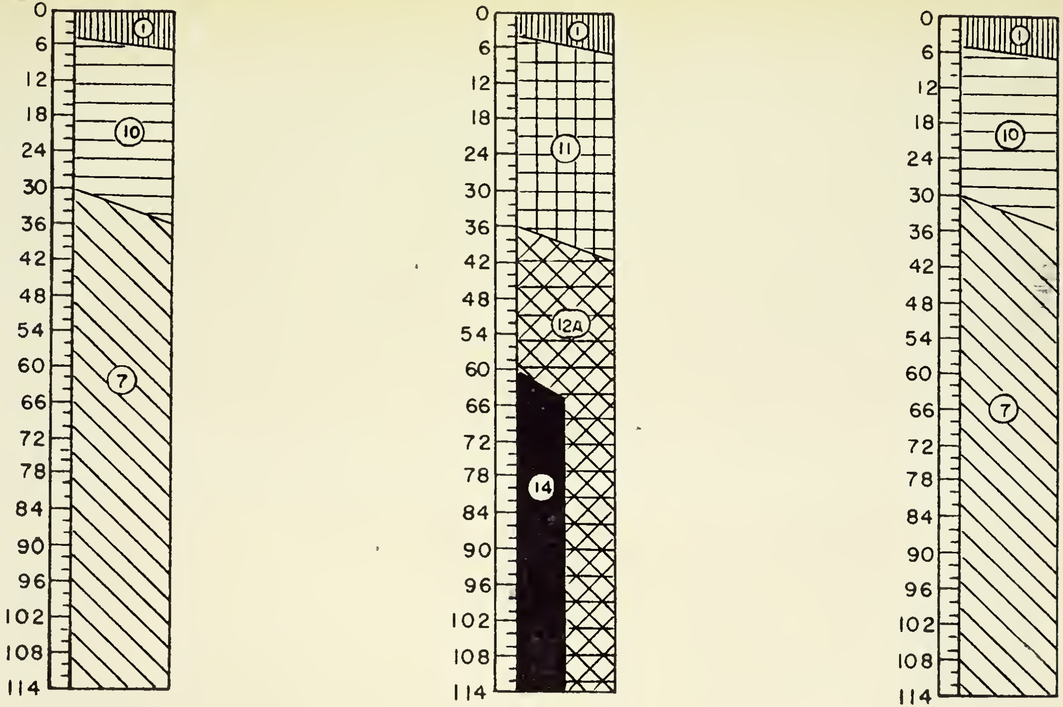
**GRANBY**

0-2 Percent

**HAGENER**

0-12 Percent

Figure A-6. Typical Profiles



JASPER

2-12 Percent

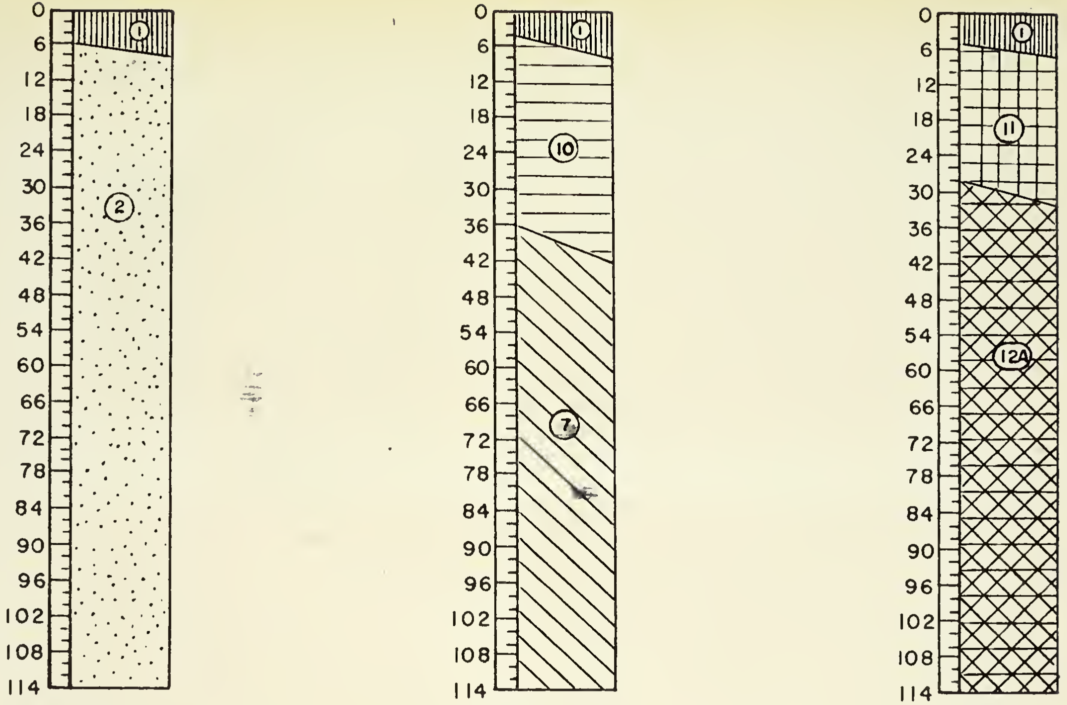
JULIAN

0-2 Percent

KIBBIE

0-2 Percent

Figure A-7. Typical Profiles



MOROCCO

0-2 Percent

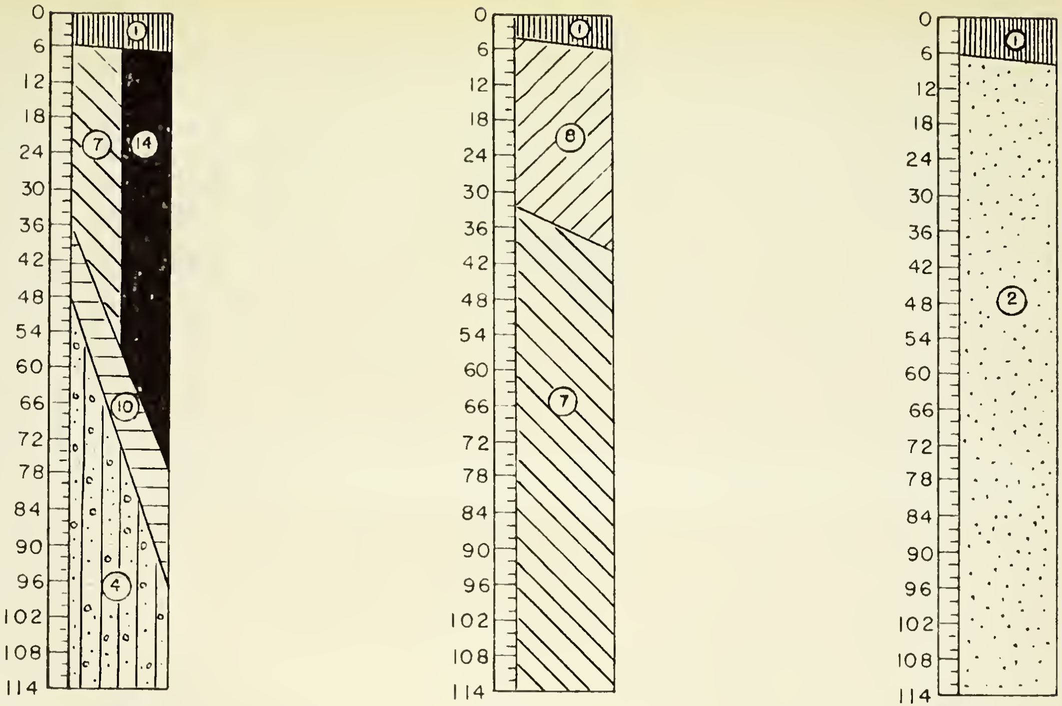
RENNSELAER

0-2 Percent

STROLE

0-2 Percent

Figure A-8. Typical Profiles



TIPPECANOE

0-2 Percent

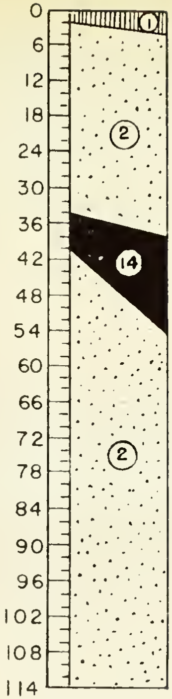
TUSCOLA

2-20 Percent

WEISS

0-2 Percent

Figure A-9. Typical Profiles



WOOTEN

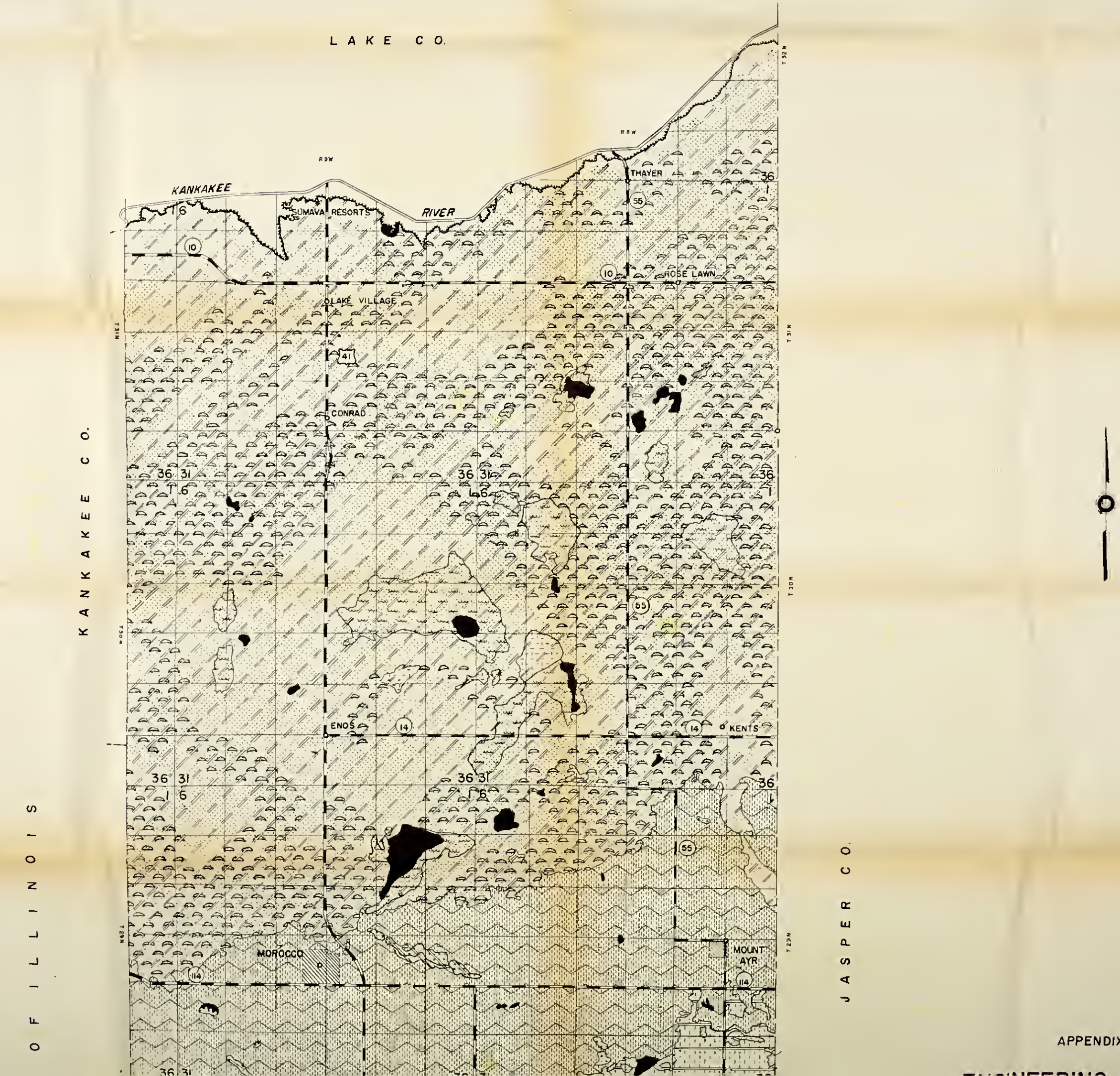
0-2 Percent

Figure A-10. Typical Profile

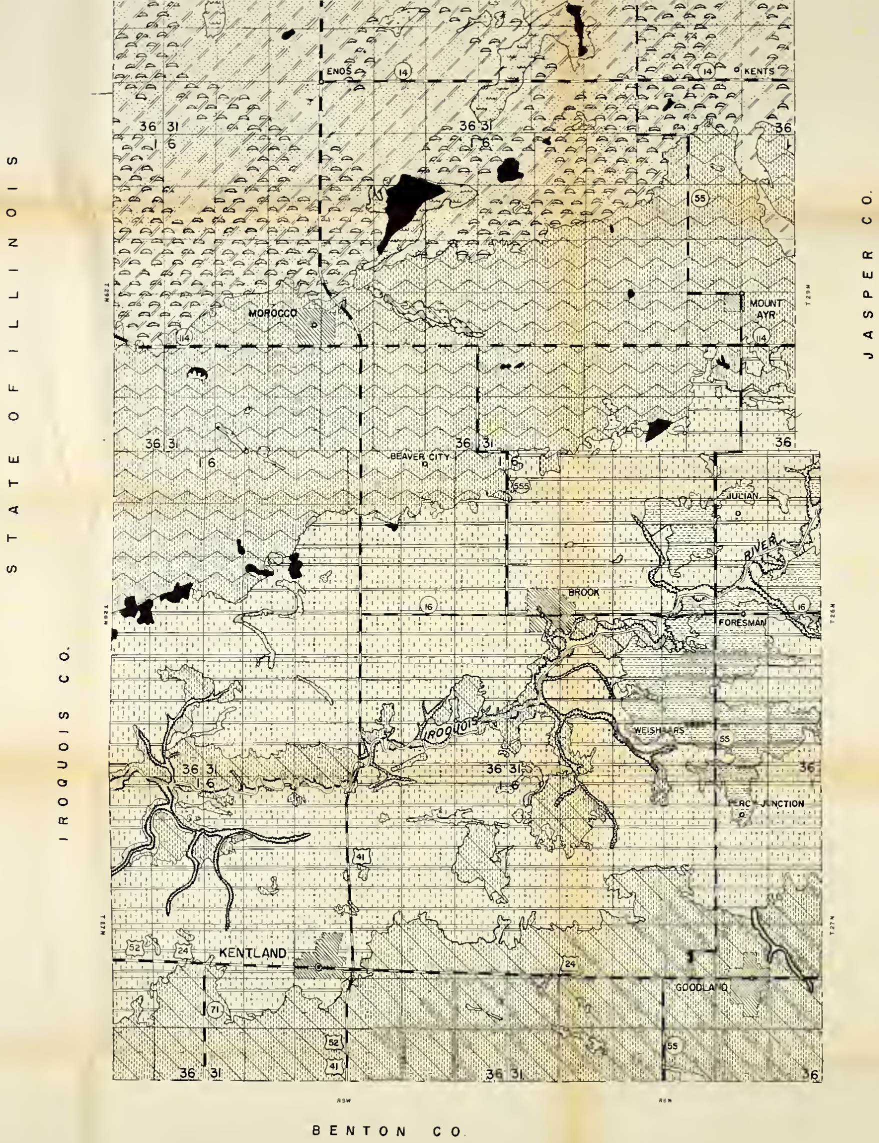
1 HCP 1950's

HRP 9- [illegible]

[illegible]


LAKE CO.
KANKAKEE
RIVER
SUMAVA RESORTS
R9W
R8W
T32N
THAYER
55
10
ROSE LAWN
LAKE VILLAGE
R10W
41
T31N
CONRAD
36 31
1 6
T30N
ENOS
14
KENTS
MOROCCO
MOUNT AYR
114
T29N
KANKAKEE CO.
OF ILLINOIS
JASPER CO.

APPENDIX B



APPENDIX B

## ENGINEERING SOILS MAP

# NEWTON COUNTY

## INDIANA

PREPARED FROM
1939 AAA AERIAL PHOTOGRAPHS
AND
AGRICULTURAL SOILS MAP
AT
PURDUE UNIVERSITY

1956

PREPARED UNDER THE SUPERVISION OF . O. D. McGREGOR